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A constantly increasing number of persons owe their lives to the use of this apparatus, which has been remarkably successful in gas and electric accidents, as well as in other cases involving suspended animation. The company has installed pulmotors in accessible positions at its various works.

In a store room were found heavy sledges on top of bins ten feet from the floor, which was caused to vibrate constantly by machinery. On the right will be noticed several projecting chisels which could easily be pushed back, and so stored that there would be no danger to the head of a passing employee.

Sketch of a simple device for preventing injuries to elevator operators. The guard plate engages the operator's foot, and either returns it to the platform of the ascending elevator, or gives him sufficient warning to withdraw it himself, and thus prevents crushing. Grievous injuries have been sustained where this hazard has not been taken care of.

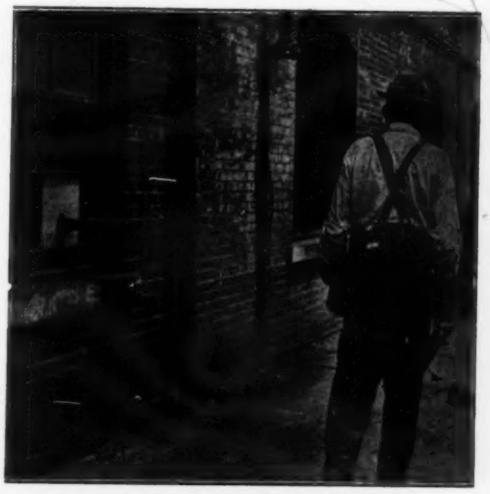
A simple hazard which resulted in a fractured foot is shown here. It consists of a short section of bent pipe which may have been placed at one time to mark the limit of an oxide bed. In this instance an employee's foot was caught and injured in the manner shown.

This picture was taken to show how employees trip over tools lying on operating floors. When thought is given to the innumerable activities of everyday life, it is remarkable how little the average man seems to think or care about the hazards surrounding him on every side.

An ugly hazard. As will be noted, the valve stem is at eye-level. The workman was photographed in the act of passing down stairs. His right foot is on the landing of the stairs, which he is facing, and which are not shown in the picture.

Picture taken to show the occasion for a guard within a guard at times. In this instance, an employee came out of the building on which the lamp is located, holding, and looking at, a chisel he was about to sharpen, and inadvertently walked through the open gateway. He unawares stepped into the separator and was scalded. Both wells are now guarded.

An exposed handle on the cover of a well, illustrating how easily an accident might occur. Under the circumstances, a fractured foot or kneecap is imminent. It is, of course, a matter of no expense to countersink the cover so that the handle will drop into, or fall flat with, the lid when not in use. A mishap under these conditions is the result of an undue feeling of security and self-sufficiency.



An exhaust pipe projecting through a window in an engine-room out into a passageway. The danger of being scalded by steam or hot water ejected from this pipe was made all the more serious by the fact that the engine was run intermittently. In an instance in which an exhaust pipe was placed somewhat lower than the one shown here, a boy's leg was scalded by the steam as he passed by.

ACCIDENT PREVENTION.—[See page 232.]

Biological Inventions*

Patenting Life Processes for Industrial Uses

The title of this paper will appear odd to many readers, who do not know that processes of animal and vegetable life can be patented—in Germany, at least. The German patent office has adapted its procedure wholly to practical utility, in defiance of theorists' expositions of patent law. Patents are granted not only for inventions but also for original productions, as in horticulture and cattle breeding, and many of these patents are of the biological class. Some of the foodstuff industries also employ biological processes, such as vinous, acetous, lactic and other fermentations, which are protected by a second group of biological patents. A third group relates to the antitoxines and protective serums which are used to combat infectious diseases.

Biological patents include all patents for processes in which the co-operation of living organisms is essential. This definition excludes devices for sowing seeds, milking cows, branding cattle, barking trees, etc., as well as pasteurizing or sterilizing processes, fungicides, the destruction of mice and vermin by electricity or poisonous gases, etc., all processes in which living organisms cooperate only by succumbing.

We will now review the multifarious patents of Class 45, which includes agriculture, horticulture, forestry, dairies, the breeding and rearing of animals, the capture or expulsion of insects and animal marauders, etc.

First comes a series of patents for beet culture. According to Patent 32,194 beets cultivated in the most favorable conditions, with regulated water supply, artificial illumination at night, and an artificial supply of heat and carbon dioxide in the last stage of growth, become very rich in sugar and transmit this property to the next generation, even when the seeds are sown in the open ground. Patent 43,000 describes the improvements of the beet and its seeds by boring a hole in the root and filling it with sugar, starch and nitrogenous substances. As this patent was in force five years[1], it must have been operated successfully. Patent 88,000 is for promoting the germination of beet seed by the action of sulphur dioxide or chlorine, in presence of hot, moist air. This patent was maintained eight years, and a second patent (131,302) issued to the same person and for the same purpose in 1901, is still in force. Even the propagation of beets by sprouts, cut from the parent tuber and rubbed with wood charcoal, has been patented.

A typical biological patent relates to a method of prolonging the life of cotton plantations which normally yield a full crop in the first year only. The process consists in grafting young seedlings with scions of the mother plants and subsequently grafting these, in turn, with scions from the grafted seedlings.

Patent 174,445 covers a process of cutting off or constricting the tops of sunflower plants to check upward growth and produce thick, woody stalks, which can be used as wood. Another patent relates to a method of grafting grape vines, in which a space is left between stock and graft to promote the growth of cambrian and to effect a more perfect union. The junction of two vine stems, by cutting one to a point and inserting it in a hole bored in the other, is protected by a patent still in force.

The value of pond lilies, as cut flowers, is impaired by their habit of closing periodically. A German florist has patented three methods of preventing this closure, by injecting metallic solutions into the flowers or their stalks, or by heating the flowers to about 130 deg. Fahr.

The process of preserving flowers by keeping them at a temperature a little below freezing was protected by a patent during six years: Forcing flowering bulbs to early maturity by dipping them in weak hydrochloric acid has been patented, but no patent appears to have been granted for forcing with chloroform and ether.

According to Patent 165,627 very hardy strains of some plants can be obtained by breeding from the plants that first become coated with ice in cold weather. A patent, in force eight years, protected a method of raising asparagus, in which the growth was first forced by heat and afterward checked by cold.

For methods of blanching asparagus two patents have been issued: one for inclosing the shoots in drawpipes, and the other for simply covering the trenches.

Many plants are killed by total exclusion of light. This is the basic principle of a patented process of covering the soil to prevent the growth of weeds.

Patent 60,883 describes a method of cultivating mushrooms in chopped straw or peat, irrigated with solutions of nutrient salts. A patent for the treatment of grain fields with fluorides leaves the reader in doubt whether the object sought is destruction of injurious germs or direct stimulation of the grain.

Essentially biological are the widely-known patented processes for increasing the nitrogenous constituents of the soil by inoculation with certain species of bacteria. The oldest of these patents, which prescribed the addition to the seed of cultures of the nodule-forming bacilli of leguminous plants, was maintained in force eleven years, and another patent, which substituted the Ellenbach bacillus, enjoyed a life of eight years. Still in force is Patent 228,592, which employs a mixture of leguminous bacilli with aerobic nitrogen-fixing organisms. Earth or peat is saturated with a solution of salt and sugar containing these organisms, and is then dried. Another patent seeks to promote the development of leguminous bacteria by supplying them with acid phosphates, in addition to carbon and nitrogen compounds. Still another patent aims at increasing the fertilizer value of industrial waste products by the addition of alkalies and nitrobacteria.

Especially interesting is a recently patented process of cultivating certain soil bacteria in liquid wastes of the sulphite paper process neutralized with lime. In this medium, rich in carbon, the bacteria thrived, as well as in humus, and assimilate nitrogen abundantly. In this connection the writer ventures to suggest the probability that algæ also possess the power of fixing atmospheric nitrogen.

Turning from plants to animals we find a patent for converting the amids of molasses, distilling water, etc., into albumen by inoculation with *Penicillium*, *Mucor* and other fungi, and thus making these watse products valuable for cattle feeding.

The sterilization of sewage for fish culture is described in Patent 101,706. The sewage is first conducted into a tank in which it becomes filled with bacteria, then into a second tank, where these bacteria serve as food for small crustaceans, which, in turn, form the food of fishes kept in a third basin.

Another patent covers the breeding of water insects as food for fish. The multiplication of the insects is promoted by providing favorable sites for egg-laying in a reservoir which contains no fish, and the insect-filled water flows through a conduit to the fish pond.

In a very amusing patent the inventor describes the propagation of maggots—not in his brain, but in meat placed in a dark room. Flies, attracted by the smell of the meat, enter through a dark passage, which they are unable to find after they have laid their eggs. They are then lured by a gleam of light into an adjoining room where they are killed by any appropriate means. It is not surprising that a patent of so little practical utility was maintained in force only two years.

All of the few patents issued in this particular field have been short-lived. The patented process of surrounding mushroom beds with red cloths to drive away insects lived only four years. The inventor of a process for protecting crops from earthworms by agitating horizontal rods buried in the ground could not have made his patent pay on the license system, because he could not have prevented the unlicensed employment of thousands of gardeners. The same reasoning applies to a patent for preventing the swarming of bees by closing the hive, so that the home-coming workers are compelled to take refuge in other hives and the colony, thus diminished in number, no longer experiences the need of swarming.

Everyone has seen, on window-panes in autumn, dead flies surrounded by a white growth of *Empusa muscal*, a fungus first described by Goethe. A method of infecting vermin with similar deadly fungi has been patented.

A patent process of protecting garments from moths by the application of bitter liquids is biological to the extent that the moths must taste the bitter substance before they can be repelled by it.

A more lucrative patent than the above relates to a method of continuous irrigation of the gills of fishes and crabs, in order to keep them alive during transport.

This practically concludes the list of biological patents in Class 45. We will now consider a much smaller group of patents, which relate to the production of articles of food with the aid of micro-organisms.

For many centuries bread has been raised with the yeast of sour dough, or leaven. When, therefore, the employment of yeast and acidifying bacteria is mentioned in a patent, we may be sure that the patent has not been granted for this expedient alone. Patent 178,538, for example, describes the production of bread rich in albumen by a peculiar process. An alkaline fermentation is first produced in a mixture of albumen, water flour, dry yeast and alkaline salts which serve as nutriment for bacteria. More flour is then added and the ordinary operations of fermentation and baking follow.

A patent has been granted for increasing the leavening power of yeast by conducting the fermentation in a partial vacuum. Another patent covers the raising of dough by means of lactic acid bacteria and sodium bicarbonate. The lactic acid produced by the bacteria combines with the sodium, and the dough is raised by the liberated carbon dioxide. A patent for making zwieback prescribes the use of dough of special composition, raised with yeast developed in grape must, to which phosphates and the spice cachou have been added.

A patent which was operated fifteen years covered the employment, in bread-making, of a wort of barley or wheat, mixed with flour and yeast. It was claimed that this nutrient fluid both promoted the growth and increased the leavening power of the yeast.

A Munich firm has patented a leaven made by subjecting malt extract, first to pure lactic acid fermentation at 120 to 130 deg. Fahr., and then to the action of yeast at the same temperature.

The employment of the yoghurt fungus, in the form of yoghurt milk, in the preparation of cakes has been patented by a Berlin company.

The production of pure cultures of yeast for alcoholic fermentation is protected by a number of patents, many of which are not explicitly biological, inasmuch as the object sought is merely the destruction of injurious germs.

In one process yeast is started in molasses and allowed to develop in a solution of pure sugar. Malt sugar is decomposed by all, cane and milk sugar by many varieties of yeast, but dextrin is little affected by any of them. A patent has been issued for a process of fermenting dextrin, in which that substance is gradually substituted for sugar in the fermenting liquid.

Vinegar is produced by the action of certain mold fungi on dilute alcoholic solutions. A patent has been granted for the promotion of the growth of these organisms by the addition of small quantities of iron and manganese salts.

Vinegar "eels," as well as acetous ferments, develop on the beech-wood chips over which the souring liquid is caused to flow in order to give free access to the oxygen required in the acetous fermentation. The eels may be destroyed, according to Patent 245,661, by adding salt and carbon dioxide.

The production of an alcoholic beverage by the action of yeast upon a sweetened decoction of tea is protected by Patent 136,006.

The demand for temperance drinks has led to the employment of numerous ferments which, unlike yeast, produce little or no alcohol. One patented process employs the fungus *Leuconostoc dissiliens* which converts the sugar of fruit juices into carbon dioxide and dextranose; another employs *Sachsia suaveoleus* for the production of aromatic substances in "soured" musts and worts; in a third, sterilized beer wort is fermented in closed vessels with the fungus *Citromyces*, which produces citric acid; in a fourth, sterilized fruit juices, exposed to the air, are fermented with *Saccharomyces* or *Mycoderma*. Nectar-producing flowers are the fermenting agents used in a process still protected by patent. The fermentation is begun in open vessels, but completed in closed vessels, under pressure. The resultant is a beverage of peculiar aroma, charged with carbon dioxide, but containing little alcohol.

In the preparation of foodstuffs, beneficial or injurious effects may be produced, independently of the activity of micro-organisms, by physiological changes in fresh animal or vegetable matter. Thus the employment, in bread-making, of flour made from malt (i. e., sprouted) grain was protected by a patent which remained in force during the full term of fifteen years.

In this connection a patent issued in 1882 deserves mention as a curiosity. The object sought was the production of dyestuffs by the fermentation of saccharine liquids containing substances of the aromatic series. The development of the aniline-dye industry destroyed the value of this patent, which remained in force only five years.

There remains for consideration patents for the production of therapeutic serums, vaccines and antitoxins. The commonest method of obtaining immunizing substances consists in the repeated injection, in increasing doses, of bacilli, their products of metabolism or other toxins, into the bodies of living animals, and extracting their blood after a certain degree of immunity has thus been produced.

This method is followed in a patented process for conferring upon cattle a high immunity to the foot-and-mouth disease, by means of the blood or the aphthous matter of infected animals. According to general opinion, however, a new preventive inoculation of human beings, analogous to vaccination for small-pox, would not be patentable.

Another patent covers the production of a curative

* An abridgment of an article by Dr. Quade, in *Prometheus*.

[1] According to German patent practice an annual tax is payable during the life of a patent, in default of which the patent expires.

serum for hog cholera by inoculating animals of a different species with killed germs from infected hogs.

Patents have also been granted for curative serums for horse plague and cattle plague, prepared from the body fluids of infected or dead animals, after removal or destruction of the virus. These patents found little opportunity for usefulness in Germany and remained in force only two years.

"Pollantin," a patented remedy for hay fever, is made by a Leipzig firm from the serum of animals which have been immunized with pollen or its constituents.

A patent has been issued for a serum obtained from rabbits or asses which have received alternate injections of the venoms of vipers and adders. This serum confers immunity to the venom of snakes of several species.

A physician of Hamburg has taken out patents for serums obtained from animals which have been artificially infected with specific diseases and cured by injections of yeast or of the serum of animals already cured. These serums have been employed chiefly in the treatment of boils and carbuncles.

Patents have also been issued for serums designed to confer immunity to poisons produced in the human body without bacterial invasion. For example, a patented antidode to the poison secreted by the thyroid gland in Basedow's disease is the serum or milk of goats from which the thyroid has been completely or partly removed. Another serum for the same purpose is obtained from animals fed on thyroid substance.

A patented serum for the cure of diabetes was obtained from animals injected with the secretion of the suprarenal capsules (which itself causes glycosuria). The inefficiency of the remedy is indicated by the short life of the patent—five years.

An extract, obtained by pressure, from the muscles of animals killed in a state of extreme fatigue has been employed to produce antidotes to fatigue-poison in other animals, but probably without success, for the patent issued for this process remained in force only four years. In another patented process, an infusion of the fresh or dried placentas of victims of eclampsia was employed to immunize animals, the serum or milk of which was used as a remedy for eclampsia.

Special difficulties have been encountered in the application of serum treatment to three diseases: typhoid fever, streptococcus infection as well as tuberculosis.

According to a patent which was allowed to lapse last year, and which presumably possessed little practical value, an animal was inoculated with a filtered typhoid culture until it yielded a serum which, even in small quantities, neutralized the "agressius" contained in similar cultures.

A streptococcus serum, employed principally in puerperal fever, is protected by a patent which has been in force six years. Virulent streptococci cultivated in defibrinated human blood are alternated by repeated sojourns in small animals, then cultivated in bouillon and finally employed in producing an immunizing serum for large animals, especially horses.

Human streptococci can be injected directly into monkeys, which then produce antitoxins for human streptococcus diseases. This process is patented, and a supplementary patent covers the production, by analogous methods, of antitoxins for gonococci, pneumococci, and meningococci, the germs of meningitis.

The proprietors of the tuberculosis remedy hetol, or sodium cinnamate, have patented a serum to be used in connection therewith. This serum is obtained from tuberculous animals which have been treated with hetol until they fail to react, or react but slightly, to subcutaneous injections of tuberculin.

Another patented immunizing serum for tuberculosis is produced by a complex process. Healthy animals are first made over-sensitive to tuberculin by injections of living tubercle bacilli taken from animals of a different species, and hence non-virulent for the animals treated. This excessive susceptibility is next destroyed by repeated and increasing injections of tuberculin or other preparations of tubercle bacilli, and is then reproduced by injecting living tubercle bacilli which are virulent for the species in question. The susceptibility is again diminished by tuberculin, again increased by virulent bacilli, until a serum capable of conferring comparative immunity is developed. Supplementary patents cover the preparation of remedial emulsions from tubercles or tuberculin treated with this serum.

A new path is blazed by a patented process in which the fungus *Trychophyton*, the germ of certain skin diseases, is cultivated on virulent-living tubercles. The fungus is then separated and extracted with glycerine and carbolic acid. The filtered, sterile extract is employed both to treat and to prevent tuberculosis.

Attention has recently been directed to the possibility of producing non-poisonous antitoxins, of the nature of ferments, *in vitro*. A patent has been issued for a process of forming antitoxins in eggs and plants.

According to the current view, cancer is not strictly a parasitic disease, yet the cancerous cell itself, abnormal in all its functional activities and capable of transmitting the disease through the blood stream or by transplantation, may be regarded as a parasite. Patents have been granted for an immunizing emulsion of bouillon or agar in which cancer cells have been propagated, and for a vaccine made from the blood (not the serum alone) of animals treated with this emulsion.

A well-known firm has patented the cultivation of pathogenic bacteria in media destitute of protein and the production of very active cultures by repeated transference to media containing progressively increasing proportions of arsenic. Another patent has been granted for improvements, produced by the action of metals, in vaccines for hemorrhagic septicæmia and in cultures of its germ. In another patented process the multiplication of bacteria is promoted by repeated transference to fresh nutrient liquids, which dissolve injurious products of their activity.

Another patent describes a method of killing tubercle bacilli for the purpose of inoculation. The bacilli are killed, not by violence, but gradually and in a natural manner by drying them in a vacuum, carefully removing all adhering culture medium, and keeping them in drying chambers for a long period.

Patent 221,666, on the contrary, covers a process of preserving the life and activity of bacterial cultures by incorporating them with warm and concentrated solutions of gelatine, which are then ground into gelatine capsules. The five last-mentioned patents are still in force.

We have reached the end of the list of biological patents. Methods of breeding and training animals are strangely excluded from the protection of patents, although horticultural processes, including the production of hybrids, are admitted. All therapeutic and hygienic measures applied to human subjects are excluded for social reasons.

Lightning Protection of Explosive Works

The effective protection against lightning of works in which explosives are manufactured does not advance much. The Faraday cage is held in high honor by some scientists and builders, and condemned as useless, if not downright dangerous, by a few. The German manufacturing chemists—i. e., the Beufsgenossenschaft der Chemischen Industrie—recently took the problem up, and charged the Physical Institute of Frankfort with an investigation; the report of this institute called forth a dissenting reply from an important and, it will be seen, directly interested firm, the Carbonitfabrik Schlebusch, and though the problem is practically left where it was, some comments on an article which appeared in the August number of the *Chemische Industrie* may be suggestive.

After a prolonged discussion of the problem in various quarters, the Prussian government decreed in November, 1906, that explosive works should be protected on the Faraday cage system. In 1910 the Carbonitfabrik Schlebusch and the Westfälisch-Anhaltische Sprengstoff A.-G. in Haltern were struck by lightning and blown up. The government withdrew its rules of 1906, and left manufacturers to act as they deemed fit. The above-mentioned report of Dr. Déguisne, of the Physikalische Institut of Frankfort, took, we think, on the whole, a common-sense view. Lightning, it pointed out, threatened danger in two ways: (1) directly by striking a building, and (2) indirectly by inducing static potential differences in the interior of buildings which would cause spark-discharges. The latter, more frequent case, would not require that the building should itself be struck. Protection against (1) was best afforded by a Faraday cage, which should be raised about 3 meters higher than the highest part of the building. The wires of the cage should be sufficiently thick to carry the heaviest currents; the cross-section should be about 25 square millimeters, though half that cross-section might suffice; on the other hand, the mesh might be wide—about 1 meter. The cage should carefully be earthed as a ring system. With regard to the question whether vertical (collector) rods should be fixed on the cage, the report stated that such rods no doubt helped to neutralize charges; but they also favored a premature discharge of atmospheric electricity, and this was most undesirable, as it would lead to the induction of charges within the building. Lightning-conductors had also been known to fail, though probably because not well earthed.

As regards (2), induced charges were best avoided by an inner cage or wire net (we will use the latter term) close to the building, lying on the roof, though better projecting above it and carried down the walls, again in a ring system, which should be well earthed; chimneys, etc., should be joined to this net and be surrounded with metal ribbon. Vertical or inclined conductor-rods should not be added to this net. All pipes entering the building should be laid underground if possible; if not, an insulated section of perhaps 3 feet length should be interposed in the conduit. Large masses of metal, boilers, lead-pans, etc., should metallically be connected where they approached one another within less than 10 centimeters (2½ inches); earthing of those metals was advisable, though not imperative.

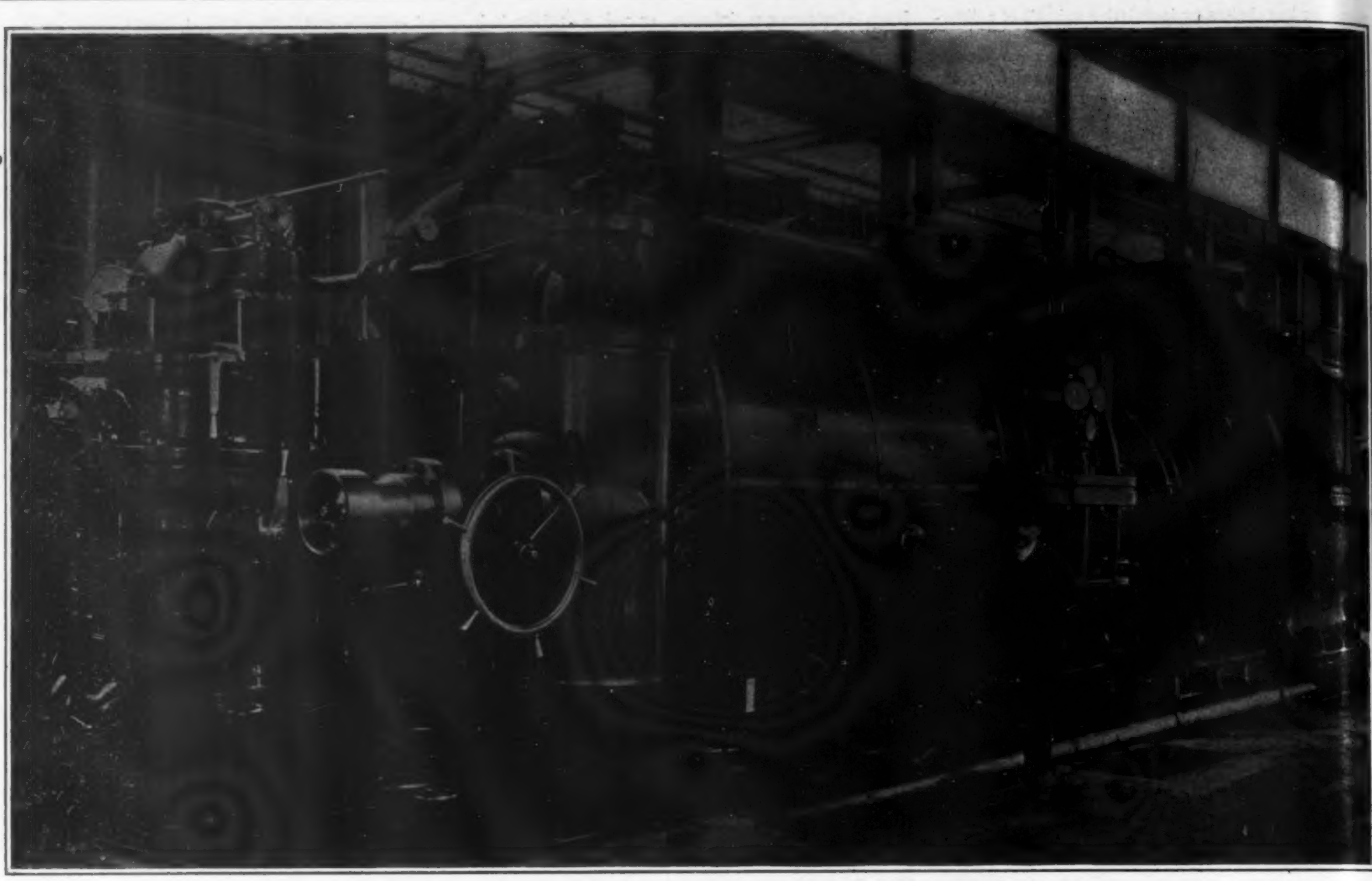
Dr. von der Hagen, of the Schlebusch Works, agreed with some of these conclusions, but strongly objected to others. His recommendations were the following: Metals should be avoided, if possible, in nitro-glycerine departments. (The perfection of stoneware pipes, valves, etc., renders this condition acceptable.) All metallic conduits should be kept underground, and be earthed before their entrance into the building, but not be interrupted by insulated sections; protective cages should not be used; lightning-conductors should be provided, and be made high on the walls, and low on the highest point of the roof; all masses of metals within the building should be joined to a ring system and earthed; good inspection of the lightning-conductors, etc., should be substituted for the accurate resistance tests sometimes demanded. These views differ from those of Déguisne in some important points. As regards earthing the conduit system and maintaining their continuity, we agree with Dr. von der Hagen; the continuity of the metallic pipes should not be interrupted, quite apart from the question that it would be exceedingly difficult to maintain the interposed section in a state of good insulation.

The general controversy, cage or conductors, cannot be summed up in a few words. But the experiments of Hagen, though hardly novel—there was, in fact, not much real novelty claimed for Sir Oliver Lodge's splash discharge demonstrations at the Institution of Electrical Engineers, which caused such a stir more than twenty years ago—will explain the chief points. Hagen placed all his apparatus on a large sheet of metal, which was joined to one pole of a Tesla transformer; whether this secondary earth was itself earthed or not, made no difference. His building was a wire cage (earthed) of the finest wire, surrounded by a second cage of coarser wire, also earthed. Inside the first cage masses of metal were placed near one another, one earthed, the other insulated. When small sparks struck a cage, no discharges were observed within the inner cage; but when greater sparks were used, there were discharges between the cages and between the masses of metal. When the distances between the parts mentioned were increased, visible displays would again cease; but sparks of greater capacity would again lead to visible discharges within the inner cage. The phenomena remained the same when the discharge struck, not the cages, but a metal rod near them. This is what we should expect. With potentials of several million volts and considerable capacity in a lightning discharge, a distance even of several meters would not render induction sparks impossible. It must further be remembered that lightning strokes are not static phenomena; it is known that the cage protection fails in high-frequency discharges. Further, every conductor has some self-induction, and the energy from a struck conductor may spurt out in all directions, whether the conductor be well earthed or not; the thickness of the wire suggested for the cages by Dr. Déguisne would hardly suffice in any case. Hagen may be right in arguing that Faraday cages to be effective would have to be placed at practically impossible heights above the buildings. We also agree that all big metallic masses should be interconnected to closed ring circuits. Whether these considerations justify a preference for the admittedly imperfect protection afforded by lightning-conductors is another question—*Engineering*.

The Gas and Electric Consumption in Greater New York

The Coal and Coke Operator, 21, No. 11,231, reports that there were 1,101,174 consumers of gas in Greater New York in 1912. The 13 different gas companies which make and sell this product made and bought during the year 55,542,488 cubic feet of gas, of which 47,775,188 cubic feet were sold to consumers. The Consolidated Gas Company had a total of 483,727 consumers, while the Brooklyn Union Gas Company had 361,845.

The electric companies generated and bought 702,174,871 kilowatt hours of electricity and sold 518,294,646 kilowatt hours. The reports of the six electric companies serving Greater New York show that there were 229,758 active meters in operation; of these, the New York Edison Company had 168,814 active meters and the Edison Illuminating Company of Brooklyn 41,684.—*The Journal of Industrial and Engineering Chemistry.*



A 25,000 horse-power steam turbine direct connected to a three-phase generator.

A Model Electric Power Plant in the Suburbs of Paris

The St. Denis Electric Power Station

By the Paris Correspondent of the Scientific American

The St. Denis electric power station situated in the suburbs of Paris is remarkable in more ways than one, and at present it appears to hold the front rank among European steam turbine plants. Installed in 1905, it has been increased as time went on by successive additions of turbines and boilers, so that at the present time its total output is no less than 120,000 horse-power. Shortly after its erection we published a complete account of the station as it was then installed, and at present we wish to refer to the present state of the plant, and especially to a new steam turbine set of larger size than usual which was set up within a recent period. It will be remembered that the St. Denis station was erected to supply the increasing needs for current in the city, as the already existing stations were working to the limit. Not only was a large amount of current needed for electric lighting, but also for the great extensions in the field of electric traction and especially for the increase in the new metropolitan subway network.

The St. Denis station is a model of excellent design, both as to convenience of working and as regards future expansion; for in course of time the city's growth will call for repeated extensions of the plant, and the additions made within even the present short period following the start will give an idea of what will certainly be called for in years to come. In order to carry out the plan of extension during a long period, the station was erected upon a large tract of ground. One end of the main machine hall, such as our photograph represents, lies in proximity to the Seine, (back ground) while at the other end the hall can be extended almost indefinitely upon ground which has been left for the purpose in the wide stretch of the St. Denis plain, and thus a great increase can be made without disturbing the existing portions. Following out the same ideas, a single boiler house is not used, but the long building is flanked by a number of separate boiler plants placed along it at intervals to correspond to a certain number of steam turbines. Back of each boiler house is an extensive coal bin, from which the fuel is delivered into the bunkers above the self-stoking boilers by electric motor driven coal conveyors of the most recent design, all being as nearly automatic as possible. Thus to increase the station all that is needed is to extend the long hall and if need be to erect another boiler house and coal bin at this point, and the rest of the station is not interfered with nor is its operation interrupted. The condensers, pumps and the like are located in the basement.

The current needed for lighting and traction for the city is generated in the shape of three-phase current at 10,000 volts for the most part, this being sent into town by underground cable and received in numerous substations for further distribution. For instance the Metropolitan subway, which also uses current from a large electric station situated within town, has quite a number of converter substations located along the subway network where the high tension current is stepped down for the subway lines. The St. Denis station commenced operations in 1905 with four steam turbine alternator groups of the Brown-Boveri type. Such turbines are designed on the Parsons system, and their size is 10,000 horse-power. The first two groups seen in the foreground of our photograph are of this kind. At an ensuing period the capacity of the station was much increased, and until lately it had ten 10,000 horse-power turbogenerator sets, making a total of 100,000 horse-power.

At that time the state of steam turbine design did not allow of exceeding this size, but it is now possible to increase the size of the units and to build turbines of 20,000 horse-power. Quite recently the Compagnie Electro-Mécanique delivered to the St. Denis plant one of the new 20,000 horse-power groups, and this is illustrated in one of our photographs. The new turbine is also of the Brown-Boveri-Parsons type, but its principal improvement over the Parsons type pure and simple is the adoption, in the high pressure part, of an impact wheel or rather set of wheels with different chambers for speed stages. Thus there is obtained an increase in efficiency in this part of the turbine as well as a marked diminution in total length of floor space. This advantage allows it to be placed in the space that was reserved for a 10,000 horse-power turbine set, so that the progress in designing is at once apparent. Our main view of the dynamo-room shows the new group on the right hand side, it being the second machine in the row. The present group operates at 750 revolutions per minute, and the guaranteed steam consumption is 5.8 kilogramme per kilowatt-hour when working at a load of 12,500 kilowatts. The condenser is located in the basement, together with its motor-driven pumps, and is of a new design to accompany the present steam turbine. As the condenser cooling water obtained from the adjoining Seine is not pure, it was found necessary to adopt a new method to allow of efficient and rapid cleaning of the tubes without shutting down the turbine. Our photograph shows the front part of the new condenser. In the Brown-Boveri patented system, the condenser is provided, as usual, with horizontal partitions in the water compartments, which assure a regular circulation of the cooling water over the surfaces, but at the same time the condenser has a central vertical partition which divides the whole into two independent parts, each having the necessary water piping. Each half of the condenser can be reached by one of the front doors, so that it can be opened up and cleaned without interfering with the other half.

A somewhat original plan had to be followed when it came to transporting the several parts of the 20,000 horse-power turbine from the construction works which lie in the neighboring region. The turbine alone weighs 140 (long) tons and is made up of three main pieces whose great size and weight made it impossible to ship them in place by railroad. In fact the rotating part weighs 40 tons and the lower half of the shell 41½ tons. The rotating part measures 25 feet 7 inches and the shell 13 feet 5 inches. In the present case the engineers were obliged to use a 12-ton wagon drawn by 35 horses for each of the three pieces of the turbine, and the transport alone cost $2,000. The paved roads did not suffer from this load even though it was quite excessive, nor did the metallic bridges along the route. However, it should be noted that considering the great difficulties of transport, they must be considered as an important factor in limiting the size of future constructions of this class.

The present status of the St. Denis plant will be seen from the following *résumé*. There are installed for producing three-phase current, 4 steam turbine groups of 10,000 horse-power and the new one of 20,000 horse-power, these turbines working at 750 r. p. m. and

Condenser with surface that can be cleaned while the 11,000 kilowatt turbo-generator is in operation.

General view of the power-room, showing one 11,000 kilowatt, ten 6,000 kilowatt, and one 300 kilowatt sets.

producing 10,250 volts at 25 cycles. Two-phase current is given by 4 turbine groups of the same size, working at 835 r. p. m., 12,500 volts and 42 cycles. Two other 10,000 horse-power turbine groups use one turbine mounted with two dynamos, that is, one alternator for 2-phase current and a second one giving 3-phase current. These three classes of machines make up the total of 10 turbines of 10,000 horse-power now in the station and one of 20,000 horse-power.

Each of the 10,000 horse-power turbines is fitted with a surface condenser installed in the basement floor. Such condensers have triplex piston air pumps driven by 50 horse-power direct current motors. In the dynamo hall is also a group of unusual kind known as "polymorphic" and containing no less than four dynamos mounted with the same turbine. These are two 2,500 horse-power (1,500 kilowatt) alternators, one for 2-phase and one for 3-phase current, and a pair of direct current dynamos for 550-volt current. This group was installed during the first period, but its use is likely to be discontinued before long.

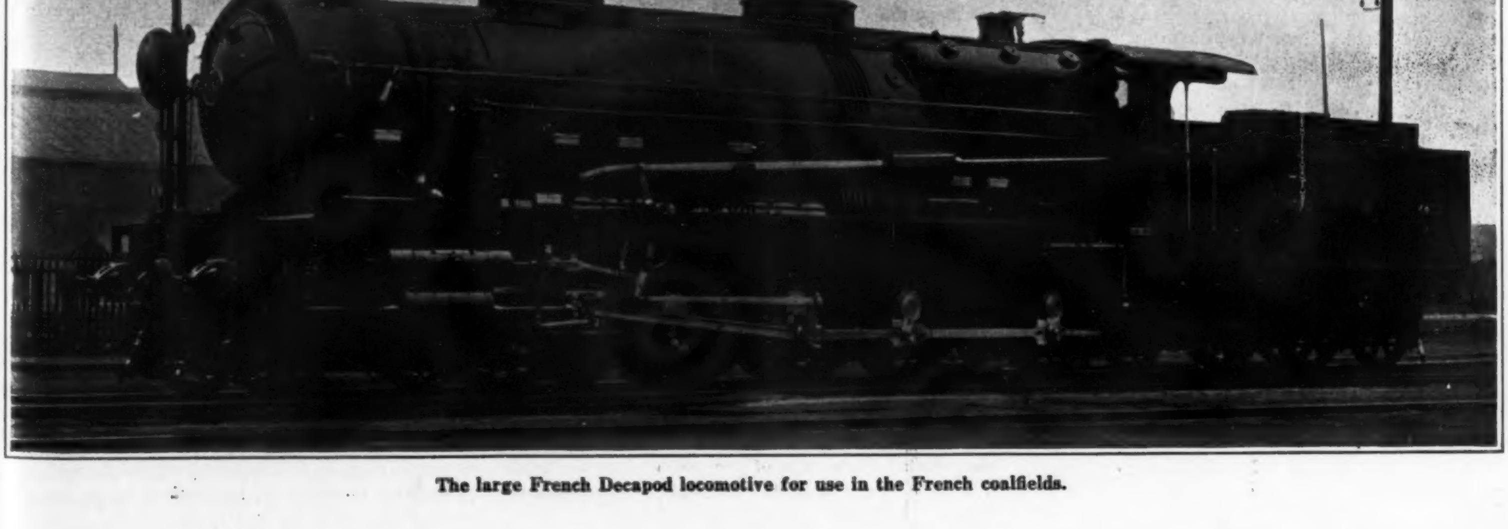
Direct current for the needs of the station for lighting and motors is obtained from several groups. One of these is a 500 horse-power steam turbine and dynamo. There are also used eight different groups consisting of 3-phase motors of various sizes coupled to direct current dynamos. The direct current is used to charge two large storage batteries. At the present stage there are erected three boiler houses with Babcock & Wilcox automatic stoking boiler sets and the same number of coal bins, the coal being brought upon Seine flats. The whole outfit includes 56 boilers, which give a total steam production which may reach 1,300,000 lbs. per hour.

An Important Locomotive Development

Large Decapod Engines for Service in the French Coalfields

By the London Correspondent of the SCIENTIFIC AMERICAN

THE Northern Railway of France, who are responsible for the working of the exceptionally heavy mineral traffic regularly passing from the Lens coalfields, have established a further record by the recent introduction of two colossal locomotives specially designed for operating extraordinary heavy mineral train loads over unusually severe gradients. These engines are each equipped with the Schmidt superheater, and are identical in all other respects with the exception that one is a four-cylinder compound of the Glehn-du Bousquet type, while the other is a four-cylinder simple locomotive with lower boiler pressure. Although the total length is very great, the rigid wheel-base has been kept within moderate limits by giving a play of 20 millimeters, (0.79 inch) in either direction to the rear coupled axle and using a Bissel truck at the front end. This truck has given perfect satisfaction in the case of the consolidation engines of this company and it was employed without alteration for the new locomotives. The frame of the Bissel is built up of steel plates, riveted together and rather resembling a gun carriage. About midway between the axle and the rear end of this frame is a socket in which works a spherical pivot. This pivot is attached to a cross-girder between the main frames through the intermediary of a horizontal



The large French Decapod locomotive for use in the French coalfields.

slide, controlled by two strong coiled springs. The pivot is allowed a lateral play of 65 millimeters, (2.6 inches). The rear extremity of the truck carries another spherical pivot, the socket of which forms part of a transverse equalizing beam, which is connected to the forward ends of the leading coupled wheel springs through a system of double knife-edges, so as to form a universal joint. Forced lubrication is provided for the sliding surfaces; and the arrangement gives great freedom of movement as well as an excellent distribution of weight. The outside cylinders are high pressure and drive the third pair of coupled wheels; the piston rods being considerably extended. The inside cylinders are somewhat inclined and drive the second coupled axle. Independent valve gear actuates the distribution, which is by piston valves for the high pressure and flat balanced slide valves for the low pressure cylinders. The gear is a Walschaerts, and is, as may be seen from the photograph, of very light and elegant construction. The following are the leading dimensions of No. 5.001: Diameter of cylinders, high pressure, 490 millimeters, (19.29 inches): low pressure, 680 millimeters, (26.77 inches): stroke, high pressure, 640 millimeters, (25.19 inches): low pressure, 700 millimeters, (27.56 inches): steam pressure in intermediate reservoir, 8 kilograms, centimeters 2, (113 lb. per square inch): diameter of driving wheels, 1.55 millimeters, (5 feet 1.02 inches): diameter of Bissel truck wheels, 1.40 meters, (3 feet 4.94 inches): wheelbase, rigid, 5.32 meters, (17 feet 5.44 inches): total wheelbase, 10.12 meters, (33 feet 2.44 inches): total length of engine 13.355 meters, (43 feet 9.78 inches): from rail to center of boiler, 2.8 meters, (9 feet 2.23 inches) from rail to top of chimney, 4.23 meters, (13 feet 10.53 inches.) There are 90 Serve tubes of 67 millimeters and 70 millimeters (2.64 inches and 2.75 inches) diameter, giving a heating surface of 234.25 square meters, (2,521.46 square feet); heating surface of firebox, 17.38 square meters, (187.08 square feet): total heating surface, 251.63 square meters, (2,708.54 square feet): grate area, 3.22 square meters, (34.66 square feet). The Schmidt superheater is composed of 24 elements, 133 millimeters (5.23 inches) diameter, and having a superheating surface of 62.23 square meters, (669.84 square feet); length between tube plates, 6 meters, (19 feet 8.2 inches); mean internal diameter of boiler, 1.639 meters, (5 feet 4.52 inches); working pressure, 16 kilograms, 2 centimeters, (227.5 lbs. per square inch); weight of locomotive in working order, 99.02 tons; empty 89.94 tons; weight available for adhesion, 88.37 tons. The tender is carried upon six wheels 1.247 meters, (4 feet 1.09 inches), diameter and weighs empty 17.175 tons. It carries 17,000 liters (17,963.6) liquid quarts of water and 4 tons of fuel. The total weight of engine and tender in running order is no less than 137.595 tons, and the total length is 18.988 meters, (62 feet 3.5 inches). No. 5.002 is identical, save in the cylinder dimensions and the boiler pressure, which is 12 kilograms, centimeters 2, (170.67 lbs. per square inch.) A comparison of the working of these two engines should furnish some useful data as to the relative economy, both in fuel and maintenance, of the compound superheater with high pressure and the simple superheater working under conditions that are more favorable to the boiler. Owing to the great diameter of the low pressure cylinders (though this has been kept down by increasing the stroke as much as is practicable) special arrangements were necessitated in order to get them in the usual position underneath the smoke box. To this end, the main frames are cut away at the sides of the low pressure cylinders, and upon the frames is riveted a steel casting. The low pressure cylinder is bolted to this casting and to the main frames. The cylinder rests within the recess upon the edge of the casting and the frames, thus eliminating any shearing stresses on the rivets and bolts uniting the main frame cylinder and the casting. Compensating beams are placed between the first and second, fourth and fifth axle springs; giving very smooth running. The Westinghouse (direct and automatic) and vacuum brakes are fitted with brake blocks upon every wheel. The theoretical maximum tractive effort of No. 5.001 is 23,617 kilograms, (52,066 pounds) running compound; 31,941 kilograms, (70,417 pounds) with direct admission to the low pressure cylinders. These large locomotives were designed by Monsieur Asselin, the engineer in chief of material and traction of the Chemin de Fer du Nord, to whose courtesy we are indebted for the loan of the photograph reproduced herewith.

Theory and Practice of Painting a Modern Steel Passenger Car*

The Functions and Essential Properties of Pigments and Vehicles Indicated in General

By J. W. Lawrie

SINCE the very general introduction of the steel passenger car into our railway service, new problems in painting and preservation of the steel have been brought to our attention. It is true that the problem of the preservation of steel is not in itself new to us, but the artistic preservation and protection of steel from corrosion, etc., is a new problem. A railway passenger coach must not only be painted carefully, but it must be painted so as to present a pleasing appearance to the eyes of the traveling public. This effect is arrived at by the color, luster, harmony of color, etc., and thus some of the pigments which have great value for steel protection cannot be used, and others that do not have merit for steel protection must be used merely on account of the color they possess. The railways in general have retained the same standard colors for steel cars that they had for wood cars. The consideration of the protection of steel has been secondary to the color of the finished coach. Fortunately, this consideration has not been felt for certain colors, because we have found good inhibiting pigments which harmonize with the color desired and afford good protection to the steel.

Paints for steel have different functions, in many respects, than those for wood. In painting steel we do not have the absorption into the pores, but to only an extremely limited extent, compared to that which we have in painting wood. For this reason there must be some other way adopted for getting the strong clinging effect that the pores of wood afford as an anchorage for the paint coats. Once we have the priming coat well anchored, the subsequent coats, if properly made and well applied, anchor themselves one on the other, all finally depending for their adherence on the fastness of the priming coat and the strength and elasticity of the paint film. With steel we have only to a very limited extent inter-crystalular crevices, most minute in size and depth. These do not afford a firm anchorage, nor is the penetration of the paint into these crevices of much value for anchorage. Sandblasting steel gives a slightly roughened surface, which aids materially in holding the paint to the steel. It is almost necessary to assist an oil paint with something which is a better adherer to steel than linseed oil. This we find in varnishes. For this reason we find in all steel primers a certain amount of varnish. At the same time the pigments which have answered for wood may or may not do for steel. Depending on the color, we may have more or less pigment to get proper opacity, for dark colors less, for light colors usually more pigment is necessary than in the paints used for wood. It has been established in a practical way, as well as experimentally, that the fewer the number of paint coats on steel which will give the maximum protection the longer wearing and better service will the paint coating give.

* Paper presented at the Eighth International Congress of Applied Chemistry.

In general, we can indicate the functions and essential properties of both the pigment and the vehicle for painting steel.

The pigment must give us the color and shade desired, opacity, thickness of film; it affects the life of the paint, both by its actinic action due to its color absorption, etc., and its chemical effect on the oils or vehicle. It should be such as to give the maximum inhibition of corrosion on the steel.

Corrosion itself may be due to several factors. Moisture must be present for continuous corrosion, acid gases and oxygen assist, and any free acid, such as is used in pickling steel is a strong inducer of corrosion. When we consider these causes, then we can attempt to get ways of overcoming the effects of these causes and so approach perfect inhibition of corrosion. It must be borne in mind, however, that inhibition of corrosion is only one of the desirable qualities of a paint for steel.

The vehicle has for its fundamental functions, the binding of the particles of pigment together, and the cementing of this bonded material onto the steel surface. It gives life to the paint and gives the finish effect desired as to luster, etc. It must also be such as to exclude from the steel surface all moisture and gases.

Both pigment and vehicle have additional functions other than those given. These mentioned are the ones of greatest consideration in the study of proper paints for steel protection.

There are essentially two or perhaps three great classes of pigments as regards their effect on steel. These classes can be called the Electrical, the Chemical and the Passifiers. Examples of the passifiers are the Chromates, which seem to render the steel immune to oxidations.

In line with the electrolytic theory of the corrosion of steel, the differences in electrical potential produce a current of electricity in the direction of the high to low, or also positive to negative. The different pigments show such differences in their relation to steel, and for this reason if we use pigments which are positive to steel, then in any flow of current we would have the positive material going into solution and the negative material, or, in this instance, the steel, protected. Such pigments would therefore be inhibitors of corrosion of steel. Those of the same potential, or neither positive nor negative to steel, would be neutrals and those negative would be accelerators.

The chemical pigments are those which through their particular chemical properties, such as acidity, either direct or through hydrolysis, neutrality, or alkalinity, affect the steel so as to inhibit or accelerate corrosion. It is practically established that there is a minimum alkalinity below which there is no inhibition, and also with too strong alkalinity the action of the pigment on the vehicle oils is so pronounced that such pigments are detrimental to the life of the paint. Practically all pigments belong to both the electrical and chemical classes. A pigment may be positive to steel, and yet in itself or by hydrolysis be so acid in action that instead of being, as we would expect, an inhibitor, it is instead, a strong accelerator of corrosion. In the same manner, a negative pigment may be sufficiently alkaline as to become an inhibitor. Many pigments are both positive and alkaline, and therefore extremely good inhibitors. Others are neutral, either through opposing electrical and chemical properties (as applied to inhibition, etc.), or are neutral of themselves in all respects. Again, other pigments are negative and acid, and so strong accelerators. There are, of course, all grades and stages in these valuations. It is, however, possible by test to identify the different properties of the different pigments and combinations of pigments, and so classify them as to their actual value for inhibiting corrosion.

The knowledge of these classes is worth having, but not of great importance, unless we have satisfactory methods of determining to which class each and every kind of pigment or mixture of pigment belongs. It is possible to measure directly differences in potential between pigments and steel, and also the relative acidity or alkalinity, either as a direct property or as one produced by hydrolysis. These tests can be applied directly to most pigments, but not to all. There is one test which can be considered final and fair. That is, an actual exposure test of the pigments combined into paints and applied to steel panels under differing exposure and weather conditions. It must be admitted at once that such tests are not absolute, but their relative value cannot be disputed. It is impossible from the results of such tests as those at Atlantic City to say that the American vermilion is 10 times as good a pigment as some other pigment which would be rated at 1. The relative fact is that American vermilion is a first-class inhibitor of corrosion, whereas the paint rated at 1 is not an inhibitor and is probably one of the negative pigment paints, and therefore an accelerator. It is extremely tedious, however, to wait four or five years for such an exposure test to give reliable results. Events and truths in paint grinding history are moving much too fast and some other means must be had for testing out these pigments and vehicles in a shorter time and yet with a reasonable amount of assurance that the results so obtained check up the actual exposure or railway service wear.

I have been experimenting for a long time with the so-called razor blade test for both pigment and vehicle. The test is made by completely separating the pigment from the vehicle by solvents and the centerfuge, so that there is no trace of the vehicle left with the pigment. The pigment is then re-ground until all of it passes through a 100-mesh sieve. It is then made into a stiff paste, with water, spread out on a square of filter paper and the emeried razor blade is wrapped up in the pigment in such a manner that the pigment is in intimate contact with the surface of the blade all

over. Here is where many fall down on the test. The wrapping up of the blade properly has much to do with the success of the experiment. The blades are now left for about twenty-one days, being kept moist all the time. They are then cleaned, re-weighed, and the loss in weight, together with the appearance of the blade, give the value of the pigment for steel protection. I have followed the results so obtained with outdoor exposure panels, and have seen the conclusions arrived at from the razor blade test check with wonderful accuracy the results obtained on exposure. As examples of these checks I give the relative values placed on some of the Atlantic City steel panels and the losses on the razor blades:

	Loss Razor Blade.	Atlantic City rating.
American Vermilion	0.0005	10
Sublimed White Lead	0.0015	9
Corroded White Lead	0.0247	2½
Red Lead	0.0003	9
Zinc Chromate	0.0004	9

I have made these tests on over 200 different pigments and mixtures of pigments, with the exposure test for a check. The results indicate that when properly carried out the blade test is reliable and of great value where time is such an important factor as in large testing laboratories.

In like manner the vehicle can be tested for its value as a resister of moisture and gases. The emeried and weighed razor blade is dipped into the separated vehicle and given two coats, with proper drying intervals. The blade is now subjected to alternating treatments with water and moist sulphur-dioxide, and carbon-dioxide gases. This treatment is continued for a period of eleven days. The blades are then cleaned and reweighed. The appearance and loss in weight give the relative value of the vehicle as a resister of moisture and gases. Here we also use the filmometer with great success. This particularly where we are called upon to test paints from competing companies, and designed for the same purpose. The test of the resistance of the film to acid and gas penetration is of extreme importance. We have in railway service to contend with sulphur-dioxide and carbon-dioxide gases, as well as an almost continuous presence of moisture. For this reason the paint must be able to exclude these gases and moisture. This exclusion depends largely on the nature of the vehicle. Straight linseed oil or soya bean or other like oils will not exclude completely. If, however, we add a gum varnish to the oil the porosity is largely stopped. This, of course, is more or less perfect, according to the amount of varnish used, its kind, etc. At the same time the physical condition of the pigment must be considered, as too coarse a pigment will practically always leave a porous film. Too much varnish on the other hand, especially in a priming coat, will leave a glossy surface, to which the second coat will not adhere well. At the same time it is well established that varnish will not carry a large amount of pigment and give successful outdoor surface. It is for this reason that there have been so many failures with the so-called "quick process methods" of finishing steel cars.

We have made many tests to establish the value of baking the paints on steel cars. Our results, and practical experience, based on these tests, has shown that the life of the baked paint on steel is prolonged wonderfully and also the adherence to the steel itself is very much better. At the same time the baking has the additional value of making the vehicle much more impervious to moisture and gases than the same vehicle unbaked. Numerous experiments with certain kinds of vehicles baked gave a resistance in this way of almost three times that of the same vehicle unbaked. The mechanical difficulties of baking an entire car are large. We are at the present time experimenting in this direction. In this respect, the removable sheathing of the modern Pullman is of a decided advantage, as it can be readily taken off, the paint removed, the sheathing repainted, baked and placed back again on the car as before. There are some other difficult problems involved in the baking of the paint. It is the best practice at the present time to bake the surfacer. This baking produces an extremely hard and brittle coat. Up to the present, when it is necessary to refinish such a car, we have not found any chemicals which will successfully remove this baked surfacer. It is, however, possible to remove all coating over the surfacer and then rebuild up again in the regular manner. Here again the problem of baking the entire car is paramount and so far we have not solved the problem with entire success.

The baking temperature and length of time baked have a great deal to do with the life service of the paint. There is, for most vehicles, a minimum heat necessary to produce the internal changes in the vehicle, which give it the valuable properties so desired. This change has also a time factor. In general, the lower the temperature and the longer the time the paint is baked, the better the wear, service and resistance to moisture, and the more elastic the film. Twelve hours at 180 deg. Fahr. are better than five hours at 280 deg. Fahr.

There is no longer any argument with regard to the preparation of the steel for painting. Wherever possible sandblast. Pickle only when no other means affords itself to remove scale and rust. Pickling with sulphuric acid gives under our usual factory methods the best accelerator of corrosion of any agent met with in regular railway service. Capillary attraction is an extremely powerful force. The sulphuric acid by this force enters the spaces between the crystals of the steel and is held very tenaciously. A mere dipping in a bath of water or several baths of water fails to remove all the acid and with the hydroscopic nature of sulphuric acid an ever increasing area of steel is subjected to acid action. The whole sheet begins to corrode under the paint coat. Even with a paint which is inhibitive and moisture-proof such action will soon destroy these valuable properties. The action of the acid is cyclic and almost unending. Ferrous sulphate is readily converted to ferric sulphate and with moisture to ferric hydrate. Under these conditions the ferric hydrate is precipitated out of solution and does not react further with the acid. The acid is regenerated and again reacts with the steel, etc. The ferric oxide formed is electro negative to steel and with moisture and acid a current is established, carrying iron ions from the steel into solution. These are precipitated out as more ferric hydrate or oxide and so again the action proceeds *ad infinitum*. I would rather pickle with hydrochloric acid than with sulphuric acid even at a higher cost, because this acid is not hydroscopic; it is volatile at a low temperature and its capillary force is small compared to that of sulphuric acid. It can therefore be washed out with greater ease and sureness and can ultimately do less harm if not entirely obliterated. If you have to pickle with sulphuric acid, then wash with a stream of hot running water, so as to overcome by heat, force and dilution the capillary strength of the acid. Treat with lime water and wash again, dry and oil.

There is one feature of steel car building that is generally neglected. The outside surface of the steel is taken care of in a more or less respectful manner, but the inside of the sheet is usually given a coat of slush paint and the scale is seldom removed. Oil may be on the surface, or rust already formed. This treatment is certainly to be condemned. The inside of the outside and the outside of the inside sheets form a box with little ventilation, but usually holding a great deal of moisture. The paints used are seldom good resisters of moisture, and as a result corrosion starts and is aided by the conditions until there is often danger that the inside of the sheet will corrode through before the paint on the outside has seen decent service. As color is of no interest in this case it is easily possible to apply a good inhibiting and moisture resisting paint on these unseen sides of the sheets of steel and so prolong the life of the car very much. It is also a matter of general safety to properly paint this material, as it is impossible to get at the surface for repainting after the car is in service.

Where molding abuts on steel sheets it is usual to interpose sheet copper between the two pieces of steel. This is to produce as near a water-tight joint as possible. The fact remains that the joint is never entirely water tight. Copper is electro-negative to steel and the steel therefore goes into solution and rapid destruction takes place. I have seen siding renewed on many cars in less than nine months, and the destruction could be traced directly to this electrolytic effect. Aluminium on the other hand is electro-positive to the steel and so it goes into solution and saves the steel. It soon coats over with oxide and thus the reaction is largely diminished. The steel itself is entirely protected. This substitution of aluminium for copper was made entirely as a result of the electrolytic theory and the test of its worth by means of the well-known ferroxyl agaragar test of Cushman, Gardner, and Walker. The copper in contact with the steel in the agar jelly caused the flow of current and the liberation of iron ions, which with the ferri-cyanide gave the characteristic blue-green color. With the aluminium under the same conditions there was formed the pink, due to hydroxyl ions and the white aluminium ferricyanide.

There are several essential properties which should be possessed by the different kinds of paint used on steel. The usual procedure is first, sandblast, next prime, and following usually a second but different primer; then filler and surfacer, color and varnishes. The essentials of a good first primer or first coat of paint on steel are that it adhere well to the steel, present a good surface for the second coat, and that it have a pigment that is a good inhibitor of corrosion. It is not essential that the vehicle be altogether gas and moisture proof, although it is better so. The second coat should adhere well to the first one. It should be primarily a paint that is a good excluder of gases and moisture. It does not have to have a strongly inhibiting pigment, but it is better with such a pigment. It is usual after the application of the fillers and surfacers to rub down to a smooth finish with water and pumice. This treatment requires undercoats, which will resist the water and next to the steel a pigment that will prevent corrosion, even if some moisture gets through the outer coats. It has been possible to get better results from two coats instead of a single primer combining all qualifications. It is more practical also to get the resistance to moisture by making both coats moisture proof than by depending on the second coat alone.

The fillers or surfacers are designed to give a film such that it can be rubbed down to a smooth surface without tare and still be flexible. Most of them are fairly brittle and all of them are hard. The brittleness is increased with the baking. It is, however, possible to make a surfacer which will be hard enough to rub well and still be very elastic. Such an elastic surfacer will give to the paint coats as a whole, much better wear and freedom from checking than a more brittle and non-elastic surfacer. The coats of color, etc., following the fillers are never or seldom baked. It is very difficult to hold the shades and finish constant when we bake the finishing color coats and varnishes.

I have tried to show the theory of steel car painting as it has been applied with some success in a practical manner on a large scale. We are using the tests and theories described every day and with increasing confidence in their practical value. There are still many new phases of the work to be thought out and problems to be solved. We need more men with a little time for the practical theoretical work of the proper protection of the steel passenger car.

Trachoma

This disease of the eyes is becoming of greater importance as it becomes more widespread throughout our country. In 1897 the Secretary of the Treasury declared trachoma a dangerous contagious disease, and denied an immigrant afflicted with it entrance to this country, because of the discovery that the disease was being introduced and disseminated by immigrants. It seems to be undisputed that no country is free from the ravages of the disease, the history of which goes back to ancient times, and that no race is immune from it and no age exempt, except the very young. The cause of trachoma is not yet known, as the specific germ has not yet been discovered. The disease occurs in groups, in localities, in houses, in factories, and in schools, and is spread by contact or by contamination with articles like common towels, which are handled by the afflicted patient and his fellows.

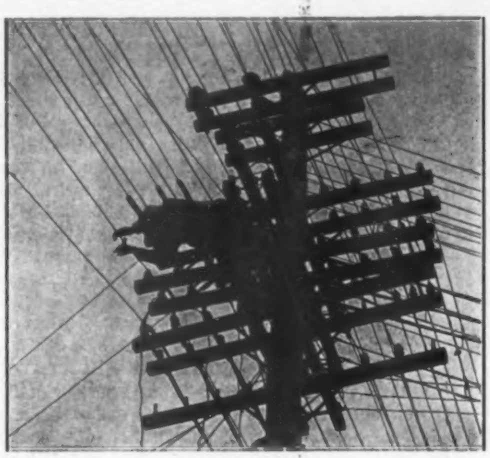
The seriousness of trachoma, its contagiousness, the knowledge that thousands of would-be immigrants are waiting to come to America if restriction of this disease is removed, the amount of it already in this country, and, especially, its concentration in certain localities, mean that measures for its prevention should be inaugurated by every State, city and town where the disease has been discovered. Poverty, crowding, dirt and articles used in common tend to spread this infection rapidly. While the number of persons having trachoma may be diminishing in some of our larger cities where both the Government and the local authorities are alert to the danger of the disease and to the segrgegation necessary, other cities and communities should pass such ordinances as would cause every case of trachoma to be reported. School children should be inspected, for this disease. Factories should also be inspected, and where the disease is discovered the owners should take measures to prevent its spread and to eliminate it if possible. A person with trachoma should be isolated and treated until he is well. A child who is discovered to have trachoma and is banished from school should be followed to its home by a visiting nurse or some inspector from the board of health to insure that the child does not spread contagion in its own home. School washrooms shuld have faucets for running water which are controlled by foot-pressure, so that the hands need not touch the faucets. The common towel should be abolished with the common drinking cup. These rules for cleanliness apply also to factories, hotels, office buildings and all public institutions.—*School Science and Mathematics.*

Standard Time in Brazil.—The government of Brazil has adopted standard time. The country has been divided into four zones, which will use the time of the 30th, 45th, 60th, and 75th meridians west of Greenwich, respectively.

Accident Prevention*

By James B. Douglas

Accident Prevention Means the Avoidance of Untold Misery, Greater Efficiency, and a Better Feeling Among Workingmen and Their Employers



An illustration of the use of rubber gloves and safety shields by a lineman working among many wires on a corner pole. Lack of these precautions has resulted in loss of life, and the use of these safeguards should be made mandatory in work of this character.

A sledge found in actual use. A badly mushroomed head will be noted, in addition to the splintered handle. Such tools are extremely dangerous, not only to those using them, but to persons near by, for the handle may break and permit the head to fly and do injury.

WORKMEN'S compensation laws are now in operation in many of our States. Twenty-six either have these laws in operation or their preliminary bills pending, and to this fact much of the progress in accident prevention is actually due,—because every law or bill provides for compensation to an injured employee regardless of the person at fault. In addition to the good done by these laws in the prevention field, they also mean a welcome decrease in misunderstanding and litigation between employer and employee, as the schedules of compensation are specific and automatic.

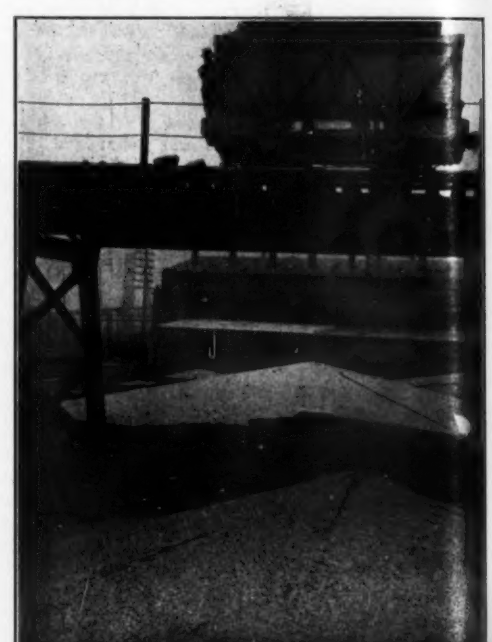
As a rule, it may be said that it is not the failure of machinery or apparatus that swells the accident total, nor is it the obscure electrical or mechanical hazard, but it is the seemingly endless number of simple and apparently trivial hazards or practices, easily recognized by one *not daily on the premises*, that causes the most suffering and loss.

First Aid is important in its place, but treatment of

* An amplified revision of an illustrated talk on accident prevention in certain public utilities presented at the Public Policy Meeting of the Thirty-sixth Annual Convention of the National Electric Light Association, Chicago, June 4th, 1913. Copyright 1913, by United Gas Improvement Co.

In many yards, ladders made simply of a pair of "two by threes" with cross strips nailed on as rungs, are in common use. The one shown, with the rungs set in and nailed, is probably as safe as a ladder of this kind can be made, but in climbing it in the manner shown, the workman has pulled a weak rung and is in danger of a nasty fall. The rungs should be mortised into the standards, instead of being nailed on as shown.

The safe method of climbing ladders. With the hands grasping the standards of the ladder illustrated, there is no danger of the rungs pulling out and throwing the workman. This and the preceding photograph were taken near a coal wharf, and it will be noticed that the workman is alive to more than one phase of the safety question. He wears goggles to avoid the danger accompanying flying coal dust and grit.



An ordinary coal trestle over which is drawn a train of loaded cars. A little farther to the right, the trestle runs over a busy public highway. It will be noted that several large pieces of coal have dropped from the cars to the edges of the trestle work and are liable to fall on the workmen below. This hazard can be overcome only by constant watchfulness, to see that the cars are not overloaded, and that the trestle and platforms are kept clear.

Here is seen a picture of a shovel, a rake and an oil can, grouped for the purpose. The shovel lies as shovels are frequently found on floors—in position to do serious injury. It may readily be appreciated how an employee running or walking carelessly might run directly into the broad edge of a shovel, which is at times as sharp as a knife. The rake introduces a liability of the teeth running into an employee's foot.

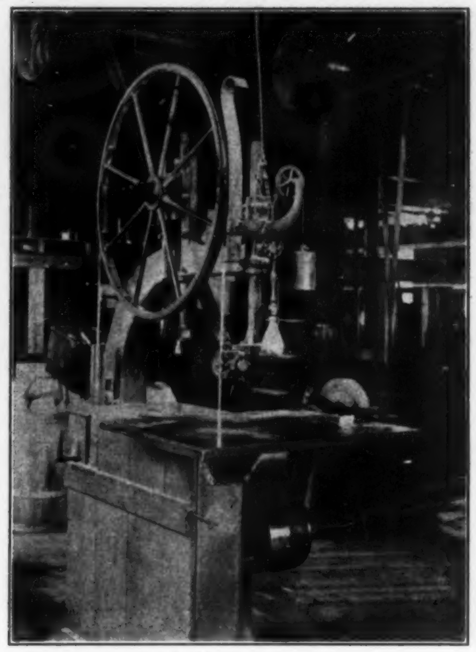
An emery wheel so guarded by an adjustable glass plate as to intercept flying emery, and thus avoid eye injuries. The iron wheel guard or hood, designed to protect workmen should the wheel burst, will also be noted. In addition the use of goggles is recommended. Reports of the number of injuries prevented by goggles are so numerous that there can be no doubt as to their value.

A particularly dangerous steam line outlet in front of a boiler. The outlet was about five feet above the floor and so placed that, should the valve be turned on, the escaping steam or hot water might scald a workman. An outlet of this sort should be arranged so as to discharge vertically, and under all circumstances be in a position to permit easy accessibility to it at all times.

An ordinary telegraph and lighting pole, to which permanent steps have been so fastened that it is a comparatively easy matter for a boy to climb them as shown. In one case, a boy climbed a pole similarly stepped, and was electrocuted. Sockets into which spikes or bolts may be inserted by the linemen in the exercise of their duty, may be used in place of steps up to sufficient height.

A manhole cover constituting a common tripping hazard. The tripping hazard, however, is not the only one. Owing to the size of the ring, the foot of an employee walking along, particularly at night, might become wedged in the ring and broken. The cover is just at the entrance to a building. The ring, of course, should be countersunk so as to drop level with the cover, in which case any mishap could be plainly avoided.

Wheelbarrows so stored that the handles may strike a passing employee in the groin. It merely suggests more careful storage, but telling workmen to be cautious and to take advantage of the safety methods provided will by itself accomplish little in the way of preventing accidents. The great residuratum is to educate an employee to be alive to even the slightest danger surrounding him—and to be careful.



Band saw not fully guarded. That part exposed to the greatest danger of breaking is immediately above the work, and it is a comparatively simple matter to fit a piece of channel iron, attached to the frame, directly over the saw in such a manner as to cover it almost completely and still not interfere with the work. A similar piece may be fitted to the back, so that in shifting work there will be no danger of striking the running saw and knocking it off the wheels.

this character should not be allowed to overshadow the vastly more important work of Accident Prevention. Thorough preventive measures will make first aid unnecessary.

In spite of the constant endeavors of workers in this field to bring the subject of safety effectively before employes by means of talks and demonstrations, the difficulty seems to have been to draw it to their attention in forms which they can understand and readily use, and it is this need that this little book is, in a measure, intended to fill. Though this material has been designed for the use of superintendents, the nature of the conditions to which attention is drawn is such that the illustrations should prove of value to foremen and employees in general, who, it is hoped, will thoroughly familiarize themselves with the hazards indicated, in order that they may promptly recognize any similar hazards within their own territory.

The illustrations are taken from a collection used in the form of lantern slides, which have been found, along with motion pictures, to be the best way to bring the various risks impressively home to neglectful employees.

While we all, of course, desire to prevent accidents from a humanitarian viewpoint, the consideration being an economical one as well, we should ever bear in mind that an accident avoided means money saved, efficiency undisturbed, production uninterrupted.

Inherent in all men is a tendency to carelessness which, in many hazardous occupations, reaches a point where familiarity with the risk occasions a sort of contempt that only too often results disastrously.

When thought is given to the innumerable activities of everyday life, it is remarkable how little the average man seems to think or care about the hazards surrounding him on every side. As a rule he does not see how they can affect him. Even where a man has witnessed an accident due to carelessness, the lesson is shortlived at best. He may have his own ideas as to who or what was to blame for the mishap, and, thinking that he will not repeat the mistake, becomes possessed by a feeling of security and self-sufficiency which at times results in the happening of the very accident for which he should have been prepared through the experience of his fellow-man.

Merely telling workmen to be careful and to take advantage of the safety devices provided will by itself accomplish but little in the way of preventing accidents. Warnings too often repeated and insufficiently varied, lose much of their effectiveness, no matter how attractively worded, but in using the experience of others and applying the lesson directly, the workmen become awakened to the fact that they are the greatest losers through preventable accidents.

It is said that a burnt child dreads fire, but it seems absurd for a man to wait for an accident to happen to him before he takes measures against its recurrence. A man differs from a child in that his mind is developed to such a point that he should profit by the mistakes of others without the necessity of personal experience entering into the question.

It is clear therefore that the great desideratum in accident prevention is that of educating the employees to be alive to the danger surrounding them, and to take

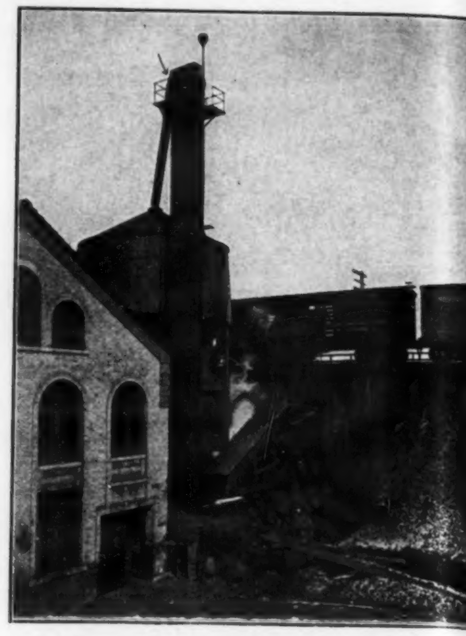
The engineer was actually seen as shown, wiping the face of a pulley carrying a large belt from an engine to a blower, while the belt was running at high speed. A mere slip, or the catching of a strand of waste in the running belt, might carry the employee's hand around the pulley, and cause the instant loss of an arm, if not of a life. The belt was guarded and instructions given how to handle.

Two types of hammers; the ordinary carpenter's, and the newer style with scored face. The statement has been made by one company that during a period of nine months, four workmen lost an eye each, due to nails flying when struck on a slant by the ordinary smooth-faced carpenter's hammer in rough work, and that since adopting the indented-head style, the hazard has well been eliminated.

At times sections of tin or corrugated iron are used to cover small openings and depressions in yards. As shown, these strips in time become buckled and raised at the edges, thereby presenting a mean hazard, particularly where employees are engaged in night work. If the obstruction is low, tripping may result only in a fall, yet even this may turn out seriously.

Hazard accompanying the standing of clinker bars, etc., against walls, pipes, or in similar locations. This workman was injured by a bar falling from the position shown. If these tools are not placed in racks, it is well to lay them flat, close to walls, where they will not cause persons to trip, or to stand them between short guide bars extending out from the wall, well above the floor.

A conveyer and crusher beside a gas house. On the side of the boxed-in conveyer is a ladder, used at times while the crusher is in operation. The hopper directing fuel into the crusher is immediately under the ladder and no guard is provided to prevent a person falling directly into the moving crusher rolls, should he slip from the ladder. The hazard presented by exposed gearing has been overlooked.



A guard, or shield, platform (indicated by the white line at the top of the hopper) to prevent a person, should he slip off the ladder, from falling into the hopper. The gearing, indicated by the arrow, has been inclosed. An employee while working around the hopper of another crusher, in some way got his arm caught in the rolls, and sustained permanent injury.

care of themselves—to be careful. The very nature of the struggle for the survival of the fittest arouses in men a selfishness of which full advantage must be taken in order that the desired results in accident prevention may be achieved. Taking any given number of hazards, a certain proportion will, without fail result unfavorably to the man taking the chances. The odds from the outset being against the man who puts himself in a position where there is a liability of injury, no one can afford to take the risk

It has been well said that *Accident Prevention Saves Misery and Money*. Until within the last few years this twofold saving has not been appreciated, and in striving to increase outputs and sales, the avoidance of accidents has been overlooked as one of the factors reducing the cost of operation. Employers at times have been slow to awaken to the fact that most of the many simple accidents could have been avoided, and have not seemed to consider seriously the great double saving to be effected through prevention. As has been indicated, efforts have been directed mostly towards reducing costs and increasing sales, with little, and at times, apparently, no regard for the saving coincident with intelligently directed work in the prevention field. It surely pays to concentrate on prevention; the *safe* way is the *progressive* way of protecting both employee and employer. A catastrophe avoided may mean lives saved and receivership averted.

An accident removes from his place, for the time being, the man his employer considers most capable in the line of work at which he is engaged. If it were not so, this man would not be holding his position. Through an injury the employer loses his services, and must replace him, temporarily at least, with a man lacking his experience and those qualities which earned him his place. Such an interruption cannot fail to show its effect on the efficiency of the plant; it disturbs the productive power and brings suffering into the family of the injured.

From any viewpoint, leaving out of consideration the humanitarian aspect of the question, the industrial loss is such as to warrant the most thorough precautions to prevent accidents, not only on the part of the employer, but of his employees as well. Accident prevention assures each workman that his normal industrial longevity will not be curtailed through the medium of preventable accidents.

To accomplish this result, the whole-hearted co-operation of employer and employees is necessary. The welfare and freedom of mind that follow the thoughtful and careful attention paid by employer and employees to the prevention of accidents, to a large extent determine the efficiency of the working force of a plant. The employer should give every consideration to suggestions that might improve the working conditions, while on the other hand every employee should consider himself an inspector for his employer in the line of work at which he is engaged. He should feel it his duty to report to his superiors any defect in materials, methods or men that may come to his attention. Every workman should realize that his own freedom from injury depends on the care exercised by him and his fellow employees, and that their safety mostly rests with themselves.

It has been variously estimated that from 30% to 50% of industrial accidents are preventable. Certain lines of endeavor include operations from which danger can never by entirely eliminated, but in all cases, carefulness brings its own reward in a marked decrease in the number of accidents, and in a reduction of the seriousness of such as may not altogether be avoided.

Presentable accidents may be classified under the following heads:

First: Use of a wrong method by the workman.
Second: Carelessness by the workman of his own safety and that of his fellow employees.
Third: Defective or unguarded machinery, tools, appliances, etc.

By far the largest number of accidents falls into the first two classes. Only care on the part of the workmen as a class will reduce the number of accidents due to these causes. The suffering and loss of time caused by accidents surely warrant the exercise of the greatest degree of care on the part of the men in the prosecution of their work, and call for their heartiest co-operation with their employers in the endeavor to prevent, and to reduce the number of, accidents.

The following illustrations of conditions, which actually have, or at any time might have, caused serious accidents, have been secured from various widely scattered sources, and many of them have formed the basis of several talks on Safety and Accident Prevention Work.

Doubtless each reader can, from his own experience, recall at least one instance of sad loss and heavy cost due to accident. When it is realized that this loss might have been avoided, we find ourselves among those anxious to seize the first opportunity to join in and throw telling efforts into the great and good cause of Prevention.

In 737 cases, at least one day's time was lost. The total time lost was 4602 days, or, on the basis of 300 working days, nearly 16 years. The average loss of time in cases where at least one day's time was lost was 6 2-3 days, practically a working week.

Of the entire number of accidents, 2,200 about 65% resulted in a loss of time that amounted only to that necessary for the proper medical attention. On the other hand, in many cases the employee was assigned to other work not necessitating the use of the injured member. However, in all cases, the suffering, inconvenience and interference with the regular line of work were so great, and so many of the accidents could have been avoided by the slightest of precautions, that these figures furnish a powerful argument in favor of *the value of care*.

In numerous instances, the prompt and efficient administration of first-aid treatment alleviated the pain and suffering to such an extent that the time lost was almost negligible, but in all minor injuries, the danger of infection through lack of attention to the wounds is so great that no one can afford to take chances.

An analysis of over 2,000 miscellaneous accidents to employees shows them to have been due to the following:

CAUSES OF ACCIDENTS.

	Number.	Percentage.
Falling objects	113	5.1%
Flying objects, cinders, dust, splashing solder, etc	138	6.3%
Protruding objects or materials	250	11.4%
Hanging or swinging objects or materials	39	1.8%
Stepping on or being caught by projecting nails, broken glass, etc.	138	6.3%
Machinery in normal operation	126	5.7%
Defects, or lack of guards, on machinery	10	.5%
Elevators, hoisting apparatus, etc	33	1.5%
Handling materials	276	12.5%
Slipping, tripping or falling	282	12.8%
Electric shock	12	.5%
Falling in or through openings	4	.2%
Handtools used by injured	322	14.6%
Tools used by fellow employees	26	1.2%
Hot objects or materials	186	8.5%
Leaking gas, sickness, etc	80	3.6%
Miscellaneous	165	7.5%
	2200	100.0%

The injuries resulting from these accidents were as follows:—

EFFECTS OF ACCIDENTS.

	Number.	Percentage.
Fractures or sprains of		
Arms, hands or fingers	58	2.6%
Legs, feet or toes	32	1.5%
Bones of body and head	26	1.2%
Eye injuries or strain	180	8.2%
Lacerations or contusions		
Head	64	2.9%
Face	59	2.7%
Body	66	3.0%
Arms	69	3.1%
Hands	273	12.4%
Fingers	638	29.0%
Legs	144	6.5%
Feet	150	6.8%
Toes	25	1.1%
General	66	3.0%
Strains or ruptures	63	2.9%
Illness	80	3.6%
Burns of		
Body	20	.9%
Face	25	1.2%
Limbs	162	7.4%
	2200	100.0%

Tree-planting Societies in Norway.—The once rapidly dwindling forests along the coast of Norway are being made to flourish again by the vigorous efforts of a large number of three-planting societies. During the past 13 years these societies have set out more than 36 million young trees. In the two counties of North and South Bergenhuus alone there are 144 tree-planting societies, which last year planted 2,276,000 trees.

The Michigan Iron Ranges*

By P. B. McDonald

The early method of exploration for iron ore in the Lake Superior district was to find a good-looking outcrop of ore formation and sink a test shaft, extensions being traced by pits and trenches. In some of the older districts lines of test pits can be followed across the formation through woods and fields for half a mile or more. On account of the difficulty of sinking test shafts through the thick overburden in swamps these generally favorable areas for concentration could be prospected only along their margins.

The customary plan to-day is to diamond-drill for concentrated deposits of ore at depth, since all the surface showings have long been taken up. Swamps can be drilled almost as conveniently as higher ground, either by laying corduroy roads for transporting machinery and coal, or by doing the work in winter when access is easy. It is not uncommon to drill under a lake by setting up the drill on the ice; this was done on Lake Michigan by the Oliver Iron Mining Company.

DIAMOND DRILLING SHOULD BE DIRECTED BY COMPETENT GEOLOGISTS

In some cases, as in the Negaunee basin, courageous operators have drilled over 1,500 feet in jasper and lean ore before finding merchantable deposits. Diamond drilling costs, on the average, $3 per foot. On account of the presence of several barren formations, such as iron-stained slates, oxidized dikes, etc., which resemble quite closely the leaner phases of the ore formation, there is need of an experienced man to direct the starting and stopping of drill-holes, in order to avoid useless drilling. Moreover the best ore bodies are found in folds and intersections, requiring that close geological relationships be worked out. Several of the mining companies which are expanding, maintain geological departments for the supervision of diamond drilling and general exploration work, and usually these departments have proved profitable.

VARIATIONS IN GEOLOGY OF DIFFERENT RANGES

The general geology of the iron ores on all three ranges of Michigan is the same; the detailed geology is quite different. In general, the iron lies in what is called "ore formation," a series of sedimentary beds of both fragmental and chemically deposited material; ore formation includes iron ores, lean ores, iron carbonate and jasper, chert and various mixtures of iron and silica, with slaty phases common. Typical ore formation is banded, with alternate layers of iron oxide, silica or carbonate; leaching of the ore formation by underground waters has concentrated the iron into merchantable ores. In the Iron River and Crystal Falls districts the ore formation is commonly less than 300 feet thick and occurs irregularly distributed at several different horizons in discontinuous lenses through black and gray slates.

On the Marquette range the ore formation is thicker, being often over 1,000 feet, and occupies a much wider and more definite area on the surface. In all districts its original thickness, as just given, is often increased several times by folding or faulting of the strata. Associated closely with the ore formation on all ranges are slates, "greenstone" or diorite dikes, quartzite and usually dolomite. The slates and quartzite are commonly bedded parallel with the ore formation, being sedimentary rocks, but the dikes, being igenous intrusions, cut at any angle across the ore formation and are of variable shape. Ore is usually found in large troughs, more or less complex, where the ore formation is folded or intersects a dike. The actual occurrences, as proved by mining and diamond drilling, are so different and irregular that several definite cases will be described.

EXAMPLES OF SUCCESSFUL DRILLING

Fig. 1, from the Marquette range, shows a diamond-drill hole 600 feet deep which has cut 150 feet of ore. Two outcrops showed on the surface; one was a hill composed of a coarse, green, diorite dike, the other was a low mound showing Goodrich quartzite, which usually overlies ore formation on the Marquette range; at the base of the quartzite was a small showing of hard ore formation and contact conglomerate, dipping away from the dike. It was inferred from this that a diamond-drill hole across the formation and cutting the dike at depth would be likely to find a concentration on the dike, and this belief was borne out by results. Another favorable place to explore for ore in the section shown in Fig. 1 would be just under the Goodrich quartzite, where the hard ores of the Marquette district are usually found; however, most of these hard-ore horizons were explored and mined in early days.

Fig. 2, also from the Marquette range, shows a diamond-drill hole 400 feet deep cutting 200 feet of ore. The only outcrop is a ridge of pinkish Ajibik quartzite, a rock known to underlie the Siamo slate which usually forms the foot wall of the ore formation. After some trouble, the dip of the quartzite was determined; it being not readily discernible, as the quartzite was rounded and cross-cracked by weathering. The diamond-drill hole was started far enough back from the quartzite to allow for a good thickness of Siamo slate, and the hole was pointed to cut the formation approximately at right angles.

In many localities where the iron formation and foot-wall slates are covered by thick overburden, their general trend can be traced by outcrops and ridges of parallel-bedded quartzite which, being harder than the other rocks, shows more frequently in outcrops or in "hog-backs."

In Fig. 3, from the Marquette range, are shown two diamond-drill holes. The first was drilled at an angle across the dip of the formation for general results, and encountered an 80-foot dike with merchantable ore lying along the further side. Such a dike makes a favorable place for concentration, as water leaching down the dip of the ore formation is halted at the dike, which in this case was found to be several thousand feet long. A vertical hole was then drilled alongside the dike, after trying two or three churn-drill holes through the soil to locate the dike on the surface. The vertical hole found ore for 750 feet in depth, which, with an average width of 30 feet, made 1,500,000 tons for 1,000 feet in length, a fair-sized deposit.

Fig. 4 is from the Amasa district, and is a plan of surface operations, illustrating the value of dip-needle work in a drift-covered country. Two mines were known to have fair-sized orebodies, but extensions of the ore had been difficult to trace because there were no outcrops and the surface soil was 100 feet thick, making exploration expensive. There was found to be a line of maximum magnetic attraction which passed about 300 feet from the mines. This line may have been due to magnetite in the slate foot wall, in the ore, or in the hanging wall. The dip-needle line served to indicate the general direction of the formations, and showed a bend in the strata about a mile from the mines. Such a bend or angle is a favorable place to look for ore, as a pocket is there likely to exist in the foot-wall slates. A diamond-drill hole was therefore located at the bend in the formation, as indicated by the line of maximum attraction of the dip needle, and was placed about the same distance back from the line as the shafts.

EXAMPLES OF UNNECESSARY FAILURE

In Fig. 5, from the Crystal Falls district, is illustrated a drift-covered country with a diamond drill hole which was stopped in a fine-grained, gray dike because the core from the dike was not examined closely and was mistaken for the foot-wall slate. Later, another company better advised, drilled through the dike and found 100 feet of ore concentrated between two dikes intruded nearly parallel to the ore formation. The second company had the benefit of the services of an experienced geologist, who examined under a microscope the core samples from the dike and determined that they were not slate. Frequently it is difficult to distinguish in a drill core between gray slate and fine-grained dike material.

A vertical drill-hole is shown in Fig. 6, from the Marquette range. It was sunk 800 feet in the Negaunee basin and then abandoned when 100 feet more would have reached a good-sized orebody concentrated in a fold of the foot-wall slates. The hole was abandoned because it had been expensive, costing $4,000, and because a slaty phase of the ore formation was cut at 800 foot, which looked similar to foot-wall material, but in reality was not. The deep, soft orebodies of the Negaunee basin, accounted by J. R. Finlay to be the greatest ore reserve in Michigan, lay unknown for years under a flat, drift-covered surface, until George Maas and others set up diamond drills in the fields around the city of Negaunee and drilled deeper than previous underground work had gone.

Fig. 7, from the Iron River district, shows effort of a company which drilled one short hole in black slate, found no ore, and threw up its option. Later another company, more courageous, penetrated the slate and found ore. The geological occurrence in the Iron River field is somewhat different from that in the older, better known Michigan districts, because the ore occurs in irregular, discontinuous lenses in the Michigamme slate. This was for a long time confusing to mining men, because they were accustomed to see slate only in the foot wall. Many of the early companies in the Iron River field were too easily discouraged and abandoned explorations that later operators developed into large mines.

Fig. 8 is from the Menominee range. It is the plan of a mine level where a crosscut was driven 200 feet into the wall for the purpose of finding any possible lense of ore parallel to the main deposit. Nothing was encountered at first, and the crosscut was stopped; later a more careful examination of the sides of the crosscut disclosed a thin seam of ore. Upon following this up, the orebody shown in the sketch was developed. One of the peculiarities of the Old Menominee range around Iron Mountain is the fact that occasional parallel lenses of ore are found back in the walls of the main ore zone; this fact has accounted for the continued life of some of the older mines that were supposed to be worked out years ago.

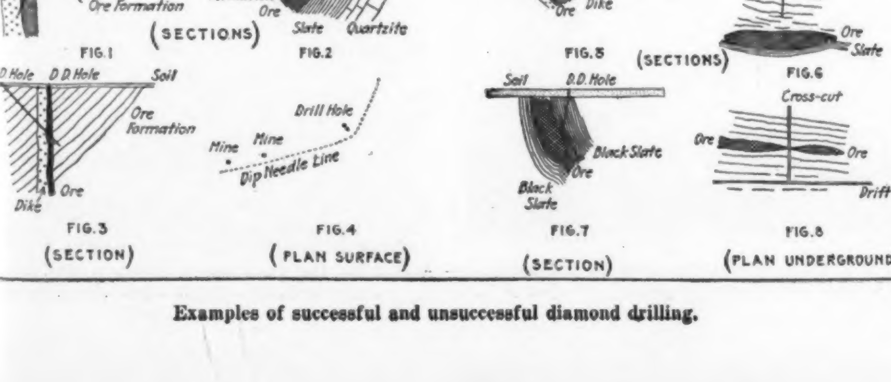
As in all mining regions, discoveries of valuable orebodies have been made as much by luck and accident as by well-advised exploration. The big Mastodon "find" recently made by the Longyear interests in the Crystal Falls district, was a triumph of skillful applied geology, but the discovery of the equally large Maas mine orebody at Negaunee a few years ago by George Maas was more in the line of luck. The story goes that Maas was in possession of an old sketch map of the Marquette district which had been made by a German who visited there at one time; printed on the map in German over the present location of the Maas mine was the remark that "here is a good place to look for iron ore."

Mining men laughed at the idea of there being ore under the flat fields where Maas began drilling, but in a short time a huge orebody of 10,000,000 tons was proved up. Other explorations by Maas at the Negaunee mine and in the extensive territory west of the American mine were considered daring ventures, but either through luck or from some other quality the results were successful and large orebodies were found.

Some of the recent discoveries of ore in the Iron River field were cases of pure accident. Many of the original settlers were Scandinavian farmers who threshed out a living on 40 or 80 acres of land. When iron ore began to be discovered in the district every farmer for miles around maintained that his land had ore on it, and several of them hung around the mining offices until some company agreed to put a hole down just for a chance.

To everyone's surprise, three or four of these chance holes struck ore, and the known ore horizons were considerably increased. Somewhat different were the explorations of W. H. Selden, of Stambaugh, who has turned over several well started ore discoveries to mining companies. Mr. Selden had lived in the mining district for some time and had been a close observer of developments; he carefully calculated the trend of the ore zones and sunk exploratory shafts, eventually proving the extension of ore west and north of the Hiawatha mine.

* Reproduced from the *Engineering and Mining Journal.*



Examples of successful and unsuccessful diamond drilling.

Attached Animals*

Examples Occur in Several Groups of the Animal Kingdom

A view showing how acorn barnacles attach themselves to the bark of a pile. Natural size.

Free movement in animals seems to possess so many advantages over the fixed or sessile habit of life that one unacquainted with the facts would hardly suppose that so large a number of aquatic animals would find it advantageous to attach themselves during some portion of their life. Yet some groups like the sponges, bryozoa and brachiopods are characteristically fixed, and numerous protozoa, the majority of coelenterates, a few worms, some echinoderms, many mollusca, some crustacea and many ascidians show this habit. A few fishes are able to attach themselves at will and some larval amphibians are fixed for a short period. This leaves only a few minor groups of invertebrates and the higher vertebrates in which no examples of the attached habit appear.

The attachment may be permanent after fixation, or it may be merely temporary, and in some cases it may be assumed at will. The advantage of such fixation is not always clear, and it is certain that it is not the same in all cases. In many marine animals living near the shore-line, attachment, either permanent or temporary, may serve to prevent the animal from being washed ashore in rough weather. In many forms, such as the encrusting corals, bryozoa and ascidians, it undoubtedly aids in protection from the predaceous enemies. In parasitic species the reason is clear enough. In certain cases permanent fixation seems to have been arrived at through crawling or creeping stages; in others it has come about through temporary attachment.

The means of fixation are as variable as the groups in which this habit occurs. It may be by means of an adhesive secretion by a suckling disk, by hooks or spines as in some parasitic species, by branching root-like structures, by horny or calcareous matters, by cellulose as in the ascidians, or by special grasping organs as may be noted in certain rotifers and crustaceans.

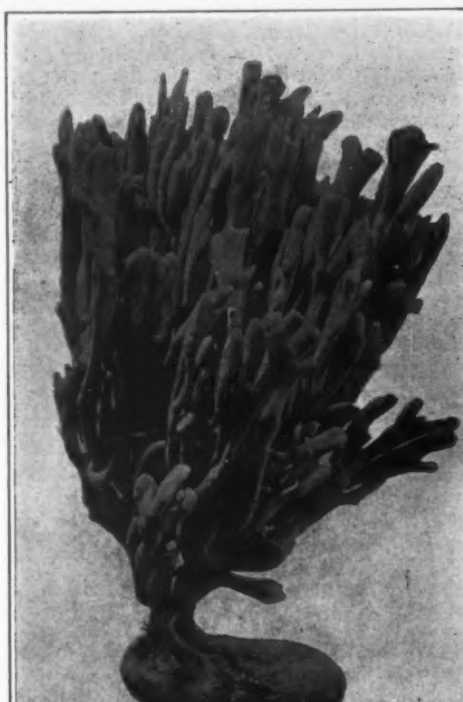
Several different methods of holding fast may occur within the same group. Thus the coelenterates may have an adhesive base, as in the common hydra and sea-anemone; there may be a horny secretion as in the case of most hydroids, and this may take the form of an expanded base, a trailing adherent rhizome, or of radical fibres, while in the corals and millepores the secretion is lime. In the mollusca attachment may be secured by means of a lime secretion as in the common oyster; by horny fibers as in the salt-water mussel; by the expanded foot as in many gastropods, or by suckers as in the temporary attachment of the octopus. In the crustacea it may be by a calcareous or horny secretion as in the acorn and goose barnacles respectively; by a branched, root-like absorbing organ as in the parasitic barnacle *Sacculina*, or the copepod *Lernaea;* by a tube as in the parasitic barnacle *Duplorbis*, or by hooked thoracic appendages, as in the parasitic isopods and some copepods.

It is evident that for purposes of distribution a free-moving stage must sometime appear in the life history of every form. Such a time occurs always in the larval life and, as a rule, a striking metamorphosis follows the attachment of the free stage. Thus the larvæ of sponges, corals, oysters, barnacles and bryozoa swim about for a time and accomplish their distribution, after which they become permanently fixed and are altogether different in appearance. The free-swimming stages of many animals were described as distinct species in many cases until the life history became known.

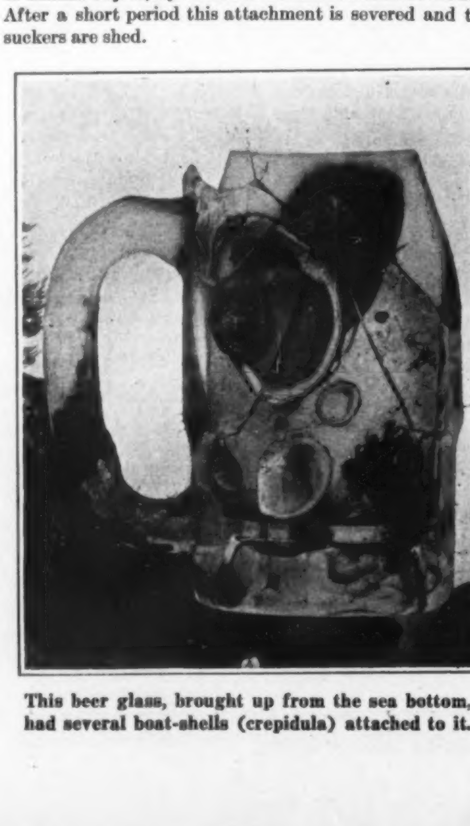
In some groups there is a definite alternation of generations; one stage fixed and reproducing sexually, followed by a free generation having sexual organs. Thus in the hydroids there are polyps which reproduce by budding. Some of the buds break loose from the colony and undergo further development into the sexual stage known as the medusa or jellyfish.

In many cases a temporary attachment is necessary for the development of the individual. Thus while most crinoids remain fastened after attachment, in the genus *Antedon* the individual severs the connection after a time and again becomes free. The same thing is true of the genus *Fungia* among the corals. In the mollusca, the common scallop, after passing through the free-swimming larval stage, attaches itself by means of horny fibers, but after a time it loses this connection and thenceforth remains free. In the fresh-water clam, also, a larval free-swimming stage (known as the Glochidium) is present, but the larva then attaches itself to the gills or skins of a fish and leads a semi-parasitic life for a time, following which it again breaks away to lead an independent existence for the rest of its life. Among the amphibia, the young tadpole of the frog, after hatching from the egg, fastens itself for a short time to the stem of a water plant or similar object, by means of suckers around its mouth. After a short period this attachment is severed and the suckers are shed.

* Reproduced from its *Bulletin*, Aquarium Number, by special permission of the New York Zoological Society.



Finger sponge (Chalina arbuscula). This specimen, a foot in height, was attached to a pebble.



This beer glass, brought up from the sea bottom, had several boat-shells (crepidula) attached to it.

Crimson sea-anemone (Tealia crassicarnis). Note the basal disk by which it is attached to the stone.

Among the forms which may attach or release themselves at will are certain protozoa, such as *Stentor;* some coelenterates, such as *Hydra* and *Leucernaria;* the species of rotifers (wheel-animalcules) which possess a grasping foot; many species of worms provided with suckers; numerous crustacea which attach themselves by their appendages; and fishes, such as the lamprey eels, which fasten themselves by a sucking mouth to the bodies of other fishes or to stones; the lump-suckers (*Cycloptеridae*), sea-snails (*Liparidae*) and the remoras (*Echeneidae*) which are provided with sucking disks formed from modified fins.

Protozoa.—The great majority of the one-celled animals are free-moving, and this is true even of the parasitic species, most of which are able to move about to some extent within the body of the host. The best known examples are *Stentor*, already alluded to as anchored at will, and *Vorticella*, which is ordinarily fixed but which may, in the presence of untoward conditions, break away from the stalk by which it is attached and swim into a new locality, where it may re-attach itself and secrete a new stalk. In the colonial *Epistylis*, the attachment is permanent. A remarkable growth of this form was recently figured covering a crayfish from Prospect Park Lake, Brooklyn. (See the Bulletin of the New York Zoological Society, No. 54, November, 1012, p. 927.)

Sponges.—These animals generally maintain their position by means of adhesive secretions of the cells in contact with the substratum. The sulphur sponge burrows into the substance of shells disintegrating them and forming nodular irregular outgrowths on the surface. The sea biscuit (*Suberites*) and similar species which grow on sandy or muddy bottom have long horny fibers which penetrate the sea bottom to hold the sponges in position. In the Venus flower-basket and glass-sponge the fibers are siliceous, and in the latter these take the form of a twisted rope of very stiff bristle-like fibers which may be a foot or more in length. These are modified spicules of the sponge, just as in the sea biscuit they are modified spongin fibers.

Coelenterates.—The common fresh-water hydra is ordinarily held in place by an adhesive base, but if food becomes scarce or other conditions improper the animal liberates itself and crawls off in search of more favorable surroundings. The sea-anemone fastens itself in the same manner and is capable of a very slow creeping movement. The majority of hydroids attach themselves by means of a horny secretion and the same is true of the sea-fans or gorgonias. Such forms are never able to free themselves. The corals and the millepores are made fast by means of a calcareous secretion and these also remain permanently fixed. Nearly all of the jellyfishes are free-swimming at all times, but the primitive *Leucernaria* has the ability to attach itself at will by means of an adhesive disk. The larval stage of *Aurelia* and certain other jellyfishes is sessile as a polyp for a period, in which condition it is known as a "scyphula." Scyphulae, probably those of the common jellyfish *Aurelia flavidula*, have lived for some years in the balanced salt-water aquaria at the New York Aquarium. They propagate freely by sexual budding, but have never metamorphosed into the adult sexual condition.

Rotifers.—The tiny wheel-animalcules are either free living, fixed or parasitic. There are two distinct methods of fixation among those which attach themselves. In one case there is a pincer-like organ at the posterior end of the body and with this apparatus the rotifer may anchor itself to any object, but such forms rarely retain the grasp for any great period. The other method is by means of a cement gland opening upon a basal expansion and species which have this method of attachment usually remain fixed as long as the conditions of life are satisfactory. Some of these build very beautiful cases into which they can retract the body when in danger.

Worms.—Numerous parasitic worms are either temporarily or permanently fastened to the body of the host by hooks or suckers, or by both at once. The adult tapeworm as an intestinal parasite, is attached to the mucus membrane, and when once it obtains a hold, never loses it. In some cases the rostrum is provided with retrorsely

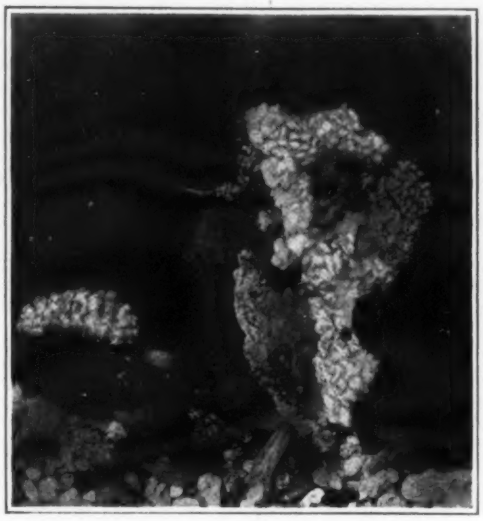
curved hooks which catch in the membrane, or the cells of the lining wall of the intestines are drawn into the suckers on the head of the worm. The fluke worms are provided with one or more suckers by which they retain their position upon or within the body of the host. Some of these worms apparently do not change their position once they have located themselves, but others move about more or less. Many marine worms live permanently in tubes of calcareous or other matter, cemented to shells, rocks, etc.

Leeches also anchor themselves when feeding by means of suckers, but these parasites affix themselves only temporarily. The highly modified myzostomas, parasitic on crinoids and starfishes, retain their hold by hooks on the appendages. Some of these external parasites move about over the host, while others live in a sessile condition and stimulate the tissues of the host to the formation of a sort of cyst somewhat like a plant gall. One species is an intestinal parasite.

Bryozoa.—These minute animals are attached throughout life, except in the larval stage. The free-swimming larva possesses an adhesive gland by which it fastens itself. It then undergoes a metamorphosis, which is followed by the usual colonial development in all except one small primitive group (genus *Loxosoma*), in which the separate individuals are fastened by a cement from the pedal glands. The colonial species, which are very numerous, have evolved various methods for attachment of the colonies. In all cases there is a secretion of chitin forming an ectocyst, or outer wall of the body. This, in many cases, is further strengthened by a secretion of lime, giving firmer attachment. The colony is spread in a layer over the substratum, or portions of the colony may rise free from one or more basal cells. In the case of the species which have a single basal cell, the attachment is usually made more secure by radical fibers, sometimes very numerous, which arise from other cells of the colony, and assist in holding it in position. In not a few instances the colony spreads by means of a rhizome, occasionally burrowing partially or entirely within the substratum. In one case, the fresh-water *Cristatella*, the colony is able to move about slowly.

Brachiopods. As a rule the members of this group are attached by means of a pedicle or stalk passing between the valves of the shell or piercing one of the valves. Rarely, in fossil forms, the foot is absent and the animal is fastened by the whole under shell.

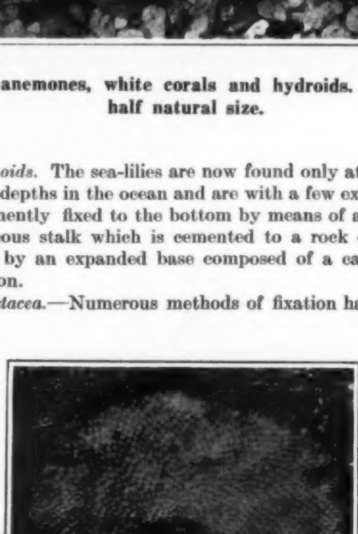
Mollusca. It is natural that in such a large and variable group different methods of attachment should have been evolved. Three methods are common. First, by means of horny fibers forming what is known as the byssus, such as in the common salt-water mussel. The fibers are secreted by a gland in that portion of the body known as the foot in the free-moving mussels and clams. In the second case, typified by the common oyster, the under valve is attached directly by a secretion of lime, often so firmly that it is difficult to dislodge it. The oyster is said to trap the raccoon sometimes by catching his foot between the valves of its shell. In the third case, which is common to many of the univalves or gastropod mussels, there is an expanded disk or foot which, in attachment, acts like a sucker. In most cases these forms move about by means of the same organ. Thus the common water-snails hold fast by this foot and move slowly along in search of food. The limpet is a very much flattened gastropod which as a rule moves about but little. It is astonishing how firmly these animals can retain their hold. The ear-shell (*Haliotus*) of the Pacific coast holds to the rock so firmly that a large one has been known to trap an animal attempting to feed upon it. In one recorded case a coyote inserted his snout under the shell, when the haliotus closed down upon him holding him a prisoner. The octopus which uses its suckers for holding its prey also uses these same structures for holding onto rocks. So powerful are these suckers that the weight of the animal may be lifted by the suction of a single disk.



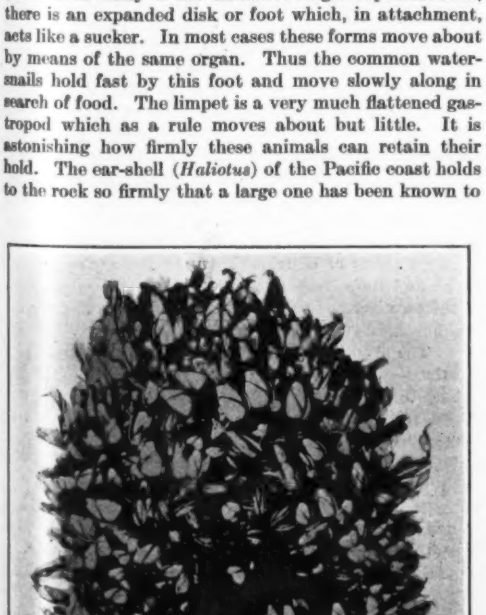
Sea-anemones, white corals and hydroids. One half natural size.

Crinoids. The sea-lilies are now found only at considerable depths in the ocean and are with a few exceptions permanently fixed to the bottom by means of a jointed calcareous stalk which is cemented to a rock or other object by an expanded base composed of a calcareous secretion.

Crustacea.—Numerous methods of fixation have been evolved in this group. The parasitic copepods and isopods usually retain their hold upon the body of the host by means of hooked appendages, but in some of the copepods, for example, *Lernea*, there is a branching, root-like sucking organ for attachment. The barnacles ordinarily are fastened by means of a chitinous stalk, or by a secretion of lime, but in the parasitic species there may be a branched or tubular absorbing organ. The hermit crab keeps its hold upon the shell in which it lives by means of the last pair of abdominal legs, which are especially modified for the purpose. It may release the hold at any time.



An encrusting bryozoan (Lepralia pallasiana) growing on a board. Enlarged twice.



Goose barnacles attached to floating timber. Much reduced.

Ascidians.—The sea-squirts secrete cellulose, a substance otherwise found only in plants, and by means of this secretion many species attach themselves to the sea-bottom. They grow singly or in colonies, sometimes forming soft crusts on rocks, shells and sea-weeds. The simple ascidians are sometimes very much appressed to the bottom, but they may be greatly elongated or stalked. In the latter case the base of the stalk is often greatly expanded or divided into finger-like processes for better anchorage.

Fishes.—None of the fishes attach themselves permanently, but in a number of widely separated groups arrangements for holding fast temporarily by sucking disks have been evolved. In the lowest group of fishes, the lampreys. there is a sucking arrangement surrounding the mouth. These fishes are temporarily parasitic upon other fishes and the sucking apparatus contains the mouth and piercing teeth or a rasping organ to obtain food.

The species known as sea-snails (*Liparidae*), lumpfishes (*Cyclopteridae*) and cling-fishes (*Gobiesocidae*) have a sucking disk on the under side of the thoracic region. In the sea-snail and lumpfish this is an elaborate affair formed by the modification of the united ventral fins. In the cling-fish, these fins are separated and the disk which lies between the fins is formed by folds of modified skin. Some of the gobies (*Gobiidae*) also have some ability for adhesion by means of the united ventral fins. The sucker enables these fishes to hold fast to rocks along the shore without danger of being washed upon the beach. Whether it may have other uses is not known. So powerful is the grasp of these sucking disks that the writer has lifted a stone weighing a pound and a half by grasping a three-inch fish which was attached to it, and some one records lifting a bucket of water by means of a lumpfish fastened to the bottom of the bucket.

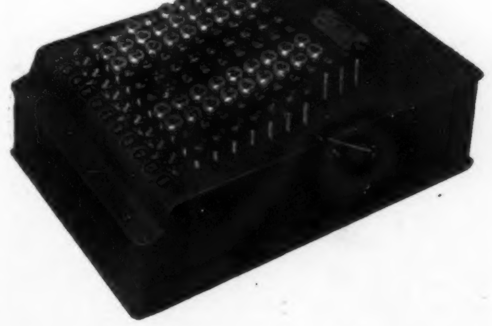
The remora or shark-sucker has on the top of the head a sucking disk formed by the modification of the first dorsal fin. This fish ordinarily attaches itself to the body of a shark or other large fish, apparently for the purpose of transportation, since it does the shark no injury. It can swim rapidly, however, on its own account, and darts about to pick up scraps of food when the large fish is feeding, or to capture fishes too small to be of interest to the shark.

One of the strangest examples to be found among fishes is that of a South American cat-fish inhabiting the mountain stream of the northern Andes. This fish has a sucking arrangement formed by an expansion of the under lip. It is not only able to hold on by this disk, but with the help of spines on the ventral fins is able to make its way up vertical rock walls past cascades.

An Improved Calculating Machine

An improved feature of the latest model of the Comptometer, a key-driven calculating machine operated like a typewriter to perform addition, subtraction, multiplication or division, is the placing of two extra rows of keys for inches and fractions to the right of the regular eight-column bank. On the first row to the right are seven keys marked in eighths. The next row contains eleven keys for inches. By this arrangement, feet, inches and eighths of inches can enter into the calculations just as if they were included in the decimal system. The register wheel under the inches column has on it 12 numbers instead of 10, and the fraction register has but 8. When the twelfth or eighth revolution is completed the whole foot or inch is carried to the next column. Thus, instead of collecting and setting down the detail measurements on the plan of a building, or the rivet spacing on a bridge member, involving a large number of items in feet, inches and fractions of inches, and then mentally adding them up, the operator presses a key for each whole number and the fraction. Without any further effort on his part the total appears in the register. Keys representing the whole item, i. e., feet, inches and the fraction, may all be pressed at one time. If pressed thrice the item is multiplied by three.

In using this machine for the checking of overall dimensions on a set of building plans previously checked by two clerks, an architect claims he discovered a dozen errors. Another case where the new model was used in a preliminary test was in checking up steel work with terra cotta walls on the total height of a 20-story building. A discrepancy of 4 inches was found by the draftsman, it is claimed, in half the time required to do the work mentally. In another fabricating plant all the figuring of estimates, formerly requiring the services of three clerks, is now done by one operator, who has 40 per cent of her time for other work. The Comptometer is made by a manufacturing company of Chicago.—*Engineering Record.*



A calculating machine with means for computing in feet, inches and fractions.

The British Association for the Advancement of Science

Abstracts of the Principal Papers

The Address to the Chemical Section.

By Professor W. P. Wynne, President of the Section.

The historian of our times will not fail to note some of the consequences which have followed the application of science to industry, possibly also some of the educational results which have followed the development of science teaching in schools of all grades. This bringing of chemistry to the people has aroused a widespread interest in some aspects of the subject.

Not even the heuristic method can hide from the schoolboy the fact that certain fundamental conceptions are accepted which do not admit of proof, such as the indivisible atom, the nondecomposable element, and the indestructibility of matter. When, therefore, as one of the first fruits of his discovery that positive rays furnish the most delicate method of chemical analysis, Sir J. J. Thomson had obtained from the most diverse solids a new gas, X_3; and by a different procedure, Professor Colie, with Mr. Patterson, had discovered that hydrogen, under the influence of electric discharges at low pressure, became replaced by neon, helium, and a third gas which was possibly identical with X_3, it is not surprising that we should hear much about it in the newspapers, just as was the case when the disintegration of radium was in process of being established.

Further investigation may fail to substantiate some of the views which have been expressed about this unexplained disappearance of hydrogen; the origin of the neon and helium which made their appearance in the tube as the experiments proceeded; the source of the gas X_3. Fortunately, X_3, unlike neon and helium, has some chemical properties—it disappears, for example, when violently exploded with a mixture of oxygen and hydrogen—but it is not yet known whether it is a new element with an atomic weight of about 3 or a compound of hydrogen with an element yet to be discovered. This much at least seems certain: it is not the gas which, according to Mendeleef, should precede fluorine in the halogen series, but whether its discovery, like that of argon, will necessitate a revision of the Periodic table of the elements they could not know until the mystery which at present surrounded it had been dispelled.

The common origin of all elementary substances was now an accepted theory, although the question whether the idea underlying the term "transmutation" was verifiable under available conditions was answered differently according to the view they took of the disintegration of radium and kindred phenomena.

The Address to the Zoological Section.

Dr. H. F. Gadow, President of the Section, said that we were not satisfied with the conviction that life was subject to an unceasing change. We wanted to understand the motive cause. It was the active search for an answer to the question Why? which was characteristic of our time. The main spring of our science was not its utility, not the desire to do good, but "blamed curiosity," the beginnings of which could be traced very far back in the lower animals. The corresponding organs of different animals afforded the absolute chance that organs of the same structure and function might not be reducible to one germ, but may be shown to have arisen independently in time as well as with reference to the space they occupy in their owners.

Meanwhile comparative anatomy would always retain the casting vote as to the degree of affinity among resemblances, but its whole work would not be restricted to this occupation. It would increasingly have to reckon with the functions, never without them. The animal refused to yield up its secrets unless it was considered as a living individual. The more elaborate certain resemblances were, the more they seemed to bear the hall-mark of near affinity of their owners. When occurring in far related groups they were taken at least as indications of the homology of the organs.

The Address in the Anthropological Section.

Sir Richard C. Temple, President of the Section, emphasised that in the matter of administration the position of the inhabitants of Great Britain was unique, it falling to their lot to govern, directly or indirectly, the lives of members of nearly every variety of the human race. Greater Britain might be said to exhibit all the many varieties of internal social relations that had been set up by tribes and groups of mankind—all the different forms of family and general social organization, of reckoning kinship, of inheritance and control of the possession of property, of dealing with the birth of children and their education and training, physical, mental, moral, and professional, in many cases by methods entirely foreign to British ideas and habits. The methods of dealing with death and bringing it about, of disposing of the dead and worshipping them, gave expression to ideas which it required study for an inhabitant of Great Britain to appreciate and understand.

As an illustration of this point, Sir Richard Temple mentioned that of all the forms of human head-hunting and other ceremonial murder that had come under his cognisance, not one had originated in callousness or cruelty of character. From the point of view of the perpetrators they were invariably resorted to for the temporal or spiritual benefit of themselves or their tribe. In order to succeed in administration, it was essential that a man should use tact. Tact was the social expression of discernment and insight, qualities born of intuitive anthropological knowledge, and it was that which it was necessary to induce in those sent abroad to become eventually the controllers of other kinds of men. What was required, therefore, was that in youth they should have imbibed the anthropological habit, so that, as a result of having been taught how to study mankind, they might learn what it was necessary to know of those about them correctly and in the shortest practicable time. The years of active life now unavoidably wasted in securing this knowledge could thus be saved, to the incalculable benefit of both the governors and the governed.

In conclusion, Sir Richard Temple argued that, from the personal point of view, it was scarcely possible to imagine any better hobby in existence. As an illustration of the processes of discovery made in it, he said that the student would find on investigation that, however childish the reasoning of savages might appear to be on abstract subjects, and however silly some of their customs might seem, they were neither childish nor silly in reality. They were almost always the result of correct argument from a false premiss, a mental process not unknown to civilized races. Nor were savages fools where their concrete interests were concerned. For example, in commerce, beads did not appeal to savages merely because they were pretty things, except for purposes of adornment. They would only part with articles they valued for particular sorts of beads, which were to them money, in that they could procure in exchange for them in their own country something they much desired. They had no other reason for accepting any kind of beads in payment for goods. It had been, he continued, his good fortune to have been partly trained in youth at a University College where the tendency was to produce men of affairs rather than men of the schools, and only recently it was his privilege to hear the present Master of the college, his own contemporary and fellow-undergraduate, expound the system of training still carried out there. "In the government of young men," he said, "intellect is all very well; but sympathy counts for very much more." That was the root principle of Applied Anthropology, and, in a nutshell, the full import of its teaching. The sound administration of the affairs of men could only be based on cultured sympathy, that sympathy on sure knowledge, that knowledge on competent study, that study on accurate inquiry, that inquiry on right method, and that method on continuous experience.

The Address to the Geographical Section.

Professor H. N. Dickson, President of the Section discussed, from the standpoint of the geographer, the probable lines of the world's development. The discovery of the two Poles of the earth had, he said, brought to a close a long and brilliant chapter in the story of geographical exploration, and the days of great pioneer discoveries in topography had definitely drawn to their close. We should still, however, be largely dependent upon work similar to that of the pioneer type, the perfecting of the geographer's principal weapon, the map. He wished particularly to call attention to a phase of pioneer exploration which had excited an increasing amount of interest in recent years. Civilized man was beginning to realize that in reducing more and more of the available surface of the earth to what he considered a habitable condition he was making so much progress, and making it so rapidly, that the problem of finding suitable accommodation for his increasing numbers must become urgent in a few generations.

As regards food, it appeared that, on a liberal estimate, the earth might, in the end, be able to feed permanently a thousand million wheat-eaters, and, if prophecies based on population statistics were trustworthy, the crisis would be upon us before the end of the century. After that, we must either depend upon some substitute to reduce the consumption per head of the staple foodstuff, or we must take to intensive farming of the most strenuous sort, absorbing enormous quantities of labor, and introducing, sooner or later, serious difficulties connected with plant food. If it was admitted that the days of extensive farming on new land were drawing to a close, then the assignment of special areas for the production of the food supply of other distant areas was also coming to its end. The opening up of such areas in which a sparse population produced food in quantities largely in excess of its own needs had been the characteristic of our time; but it must give place to a more uniform distribution of things, tending always to the condition of a moderately dense population, more uniformly distributed over large areas, capable of providing the increased labor necessary for the higher type of cultivation, and self-supporting, in respect of grain food, at least.

Considering the food problem in connection with that of mechanical energy, Professor Dickson concluded that the time when the available areas whence food supply, as represented by wheat, was derived were likely to be taxed to their full capacity was within a period of about the same length as that during which the modern Colonial system had been developing in the past, that cheap supplies of energy might continue for a longer time, though eventually they must greatly diminish, and that there must begin in the near future a great equalization in the distribution of population. This equalization would arise from a number of causes. More intensive cultivation would increase the amount of labor required in agriculture, and there would be less difference in the cost of production and yield due to differences of soil and climate. Manufacturing industries would be more uniformly distributed, because energy, obtained from a larger number of sources in the less accessible places, would be distributed over an increased number of centers. The distinction between agricultural and industrial regions would tend to become less and less clearly marked, and would eventually almost disappear in many parts of the world.

As far as the information went, we were already making serious inroads upon the resources of the whole earth. He had no desire to sound an unduly alarmist note, or to suggest that we were in imminent danger of starvation; but surely it would be well, even on the suspicion, to see if our information was adequate and our conclusions correct, and not merely to drift in a manner that was justifiable enough in Saxon times, but which, at the rate things were going now, might land us unexpectedly in difficulties of appalling magnitude. What was wanted was that we should seriously address ourselves to a stocktaking of our resources. A beginning had been made with a great map on the scale of one to a million; but that was not sufficient. We should vigorously proceed with the collection and discussion of geographical data of all kinds, so that the major natural distributions should be accurately known, and not merely those which commended themselves for one reason or another to special national or private enterprises. It was essential that there should be a definite plan of a geographical survey as a whole in order that the regional or distributional aspect should never be lost sight of. He suggested that a committee formed jointly by the great national geographical societies, or by the International Geographical Congress might be entrusted with the work of formulating some such uniform plan, and suggesting practicable methods of carrying it out. In whatever way and on whatever scale the work was done, it must be clearly understood that no partial study from the physical, or biological, or historical, or economic point of view would ever suffice. The urgent matters were questions of distribution upon the surface of the earth, and their elucidation was not the special business of the physicist, or the biologist, or the historian, or the economist, but of the geographer.

The Address to the Section of Economics.

By the Rev. Philip Wicksteed, President of the Section.

The Rev. Philip Wicksteed took as his subject "The Scope and Method of Political Economy in the Light of the 'Marginal' Theory of Distribution." He described the effects of the theory in its technical bearing on such questions as distribution and rent, and argued that convinced apostles of differential economics should revise the methods of economic exposition. If this were accomplished, he believed that all serious opposition would cease, there would once again be a body of accepted economic doctrine, Jevons's dream would be accomplished, and economic science would be re-established on a sensible basis.

It was impossible, he said, to exaggerate the importance of such a consummation. Social reformers and legislators would never be economists, but they would always work on economic theory of one kind or another. They would quote and apply such dicta as they could assimilate, and such acknowledged principles as seemed to serve their turn. If it were supposed that there were a recognized body of economic doctrine, the truth and relevancy of which perpetually revealed itself

to all who looked below the surface, which taught men what to expect and how to analyze their experience, which insisted at every turn on the illuminating relation between our conduct in life and our conduct in business, which drove the analysis of our daily administration of our individual resources deeper, and thereby dissipated the mist that hung about our economic relations, and concentrated attention upon the uniting and all penetrating principles of our study. Economics might even then be no more than a feeble barrier against passion, and might afford but a feeble light to guide honest enthusiasm; but it would exert a steady and a cumulative pressure making for the truth.

The New Sub-Section of "Psychology."

Before this new sub-section, which met for the first time this year, Dr. W. McDougall read a paper on "A New Theory of Laughter." He said that both Professor James Sully and Professor Dugas had examined the various theories of laughter and independently shown that none could be reckoned successful. Spencer regarded laughter as due to an overflow of nervous energy escaping by way of the motor nerves that were in most frequent use—namely, those leading to the muscles of speech and respiration. But there were many situations when we were moved to laugh when no surplus nervous energy was liberated in our brains. Take the case of a man sitting down on his own tall hat. Spencer suggested no reason why that should liberate surplus nervous energy in the brains of the spectators. Laughter was a highly complex co-ordinated series of movements, maintained by an impulse so strong and definite that it often defied the control of the will. Such a specific reaction, common to the whole species, implied, just as fear and anger did, that the innate constitution of the species included a corresponding psycho-physical disposition, with a special co-ordinating center in the brain.

It was highly improbable that the species had acquired this peculiar reaction if it did nothing directly to promote the welfare of the individual. All forms of laughter fell into two broad classes—the laughter occasioned by our own perception of some object or event, and the laughter which broke out independently of any such occasion. Laughter interrupted the train of mental activity, and so prevented the further play of the mind on the ludicrous object. The bodily movements of laughter hastened the circulation and respiration, raised the blood pressure, and brought about euphoria, or general well-being. Now they saw why the acquirement of laughter was worth while to the human species. Laughter was primarily the antidote of sympathy. Though it was important that we should sympathetically share the enjoyments and pains of our fellows, it would have been a serious disadvantage to suffer sympathetically all the minor pains, which were spread so abundantly around us, that one would be almost continuously subjected to a depressing influence. Hence laughter was acquired as a particular reaction.

The Panama Canal.

Dr. Vaughan Cornish, who has paid four visits to the Isthmus, dealt with the subject of the Panama Canal. The new waterway, by joining the Atlantic with the Pacific Ocean near the Equator, will put the immense length of the "Pacific slope" of the two Americas into sea communication with the manufacturing districts of the United States and Europe. Dr. Cornish gave a short sketch of the advance in the knowledge of Tropical diseases which had rendered it possible to make the Isthmus healthy, and eulogized the Americans for the establishment of orderly and civilized life in what was, after all, only a great labor camp, temporary in its constitution and polyglot in composition. The efficiency of the organization of the operative force he attributed chiefly to the exceptional qualities of Colonel Goethals, chairman and chief engineer, after whose appointment in 1907 the rapid and efficient prosecution of the undertaking commenced. The greatest engineering triumph up to the present time was the Gatun Dam. It stood solidly, in spite of the looseness of its material, and it was so broadly based that it had not sunk in the soft ground, in spite of its great weight. The water was not yet at its full depth at the back of it; but its rate of rise had been equal to that calculated beforehand, so that there was no evidence of leakage.

In regard to the slopes to be given to the sides of the Culebra Cut, all the engineers, both American and European, of the International Board appointed by President Roosevelt in 1905 had been in agreement, and all had been wrong. They had said that the rocks would stand firmly at an average slope of three vertical on two horizontal, whereas there are several miles of the Cut in which the sides are still collapsing, although the slope has been reduced to about one vertical on three horizontal—that is to say, less than one-quarter of the proposed steepness. The geologists had likewise failed to foresee the collapse of the sides, and had encouraged the engineers in their misplaced confidence. The source of error was the neglect of both engineers and geologists to take account of the chemical composition and minute mineral structure of the underlying rocks of which they had obtained specimens by boring. Some of these, lying for the most part in thin seams, were completely disintegrated when even a little rainwater reached them, and when the unbalanced pressure became considerable, on account of the deepening of the cut they flowed like sand. The banks were thus left unsupported, and they collapsed. When the disintegrated seams extended below the bottom of the cut, the accumulated pressure of the fragmentary material heaved up the bottom, often to a height of 20 ft., the mound being, moreover, broad enough to cause a serious reduction in the width of the navigable channel. This trouble still continued, and, in Dr. Cornish's opinion, was likely to continue for a long time. From his own observations on the spot, however, he concluded that, owing to the great width of the bottom of the cut, and the efficiency of the machinery for excavation and dredging, the engineers would be able to maintain a channel of sufficient width and depth for the passage of large ships. The commercial use of the canal would probably commence early in 1914.

Heredity and Man.

At the Digbeth Institute Professor Doncaster delivered a citizens' lecture on "Recent Work on Heredity and its Application to Man," and said that he had been brought into contact with certain investigations made by medical men residing in Birmingham. The subject of heredity was still in its infancy, and all knowledge had been derived from observation and the collection of pedigrees. That knowledge was, however, insufficient to explain various difficulties that arose. He proposed to deal with the Mendel system of heredity, which was that when two races, each differing in respect of any one character were crossed, and the character transmitted by one parent and not by the other, the hybrid offspring transmitted the complete character by half its germ cell, but did not transmit at all by the other half. It was a theory of great importance. Objections to the marriages of first cousins were on the ground that though the parties might appear to be perfectly normal, yet there was the possibility that both of them had received some abnormal character from their grandfather, and would thus transmit it to their children.

There had been an acrimonious controversy with regard to feeble-mindedness and alcoholism. It had been said that the former was due to the latter, but he believed it more probable that alcoholism was due to feeble-mindedness. It could be taken for granted that inheritance in man was similar to that found in animals and plants, and if a person had a disease it would be transmitted to the children, whether the environment was good or bad. The lecturer thought that a more widespread interest should be taken in the subject of heredity, as what was known at present was mere nothing compared with what remained to be known. Time should not be wasted over matters which were quite insignificant, while problems of such magnitude as heredity awaited solution.

Lantern-slides were shown illustrating characters transmitted by fowls and rabbits, and the inheritance of split foot, congenital cataract, night blindness, color blindness, nystagmas, and feeble-mindedness by human beings.

Evolution of Man from the Ape.

Professor Carveth Reed read a paper on "THE DIFFERENTIATION OF MAN FROM THE ANTHROPOIDS," in which he contended that man was descended from an anthropoid and was a beast of prey. All the prominent characteristics, functional and structural, which distinguished man from the anthropoids (except his relative nakedness) arose from his having shown a special liking for animal food. If our anthropoid ancestor was adapted to a frugivorous forest life, like the extant anthropoids, and that some, or even one, of his species had a liking for animal food strong enough to lead him persistently to seek it, and the habit was useful in increasing the supply of food, then differentiation would set in, with important results. He would be able to live on the ground and beyond the limits of the forest. He would associate with others for the purpose of hunting—especially the hunting of big-game—and, having obtained a more regular supply of food, the correspondence between seasonal marriage and birth-time and abundant food would cease. Articulate speech would arise as a means to such co-operation, and he would learn the use of wrought weapons and snares. A great increase of knowledge and intelligence would be required by the new mode of life, as more intelligence was required to catch a rabbit than to pluck a banana; and he would have to learn the different kinds of animals, to know their spoors, and how to track them to their lairs. The most successful hunter would be he who followed his prey on the ground and on foot, and thus the erect gait would become the normal mode of progression, the legs would become lengthened, the feet specialized, the arms shortened, and the hands developed. The alimentary canal would become shorter in consequence of a flesh diet, and great variability in stature, size of the brain, and shape of the skull would arise. Cannibalism, Professor Read said, may have been merely an extension of the practice of eating game to include slain members of hostile hordes. The true carnivores were not generally cannibals: it was to the experimental stage of human development that cannibals belonged.

HOW MAN LEARNED TO TALK.

Dr. L. Robinson read a paper on "The Relations of the Lower Jaw to Articulate Speech." He asked why man had a chin. Inside the chin, in the jaws of Europeans, there were distinct, body prominences, but in the jaws of apes there was a pit. He believed that the genio-glossus muscle had more to do with articulate speech than any other muscle in the tongue. In man it was large, and it decreased in the animal kingdom until in the pig it was a mere slit. In man, in fact, it became a series of muscles acting independently of one another. In every sound we uttered the muscle came into play, and in the case of a man speaking 150 words a minute its movements were from 400 to 500 per minute. Among the lower races, such as Bushmen and Hottentots, the prominences were practically undeveloped. In French and Italian jaws the tubercles were more symmetrical and regular than in English jaws, and remarkably developed in the Irish—(laughter)—as witness the case of O'Brien, the Irish giant (a cast of whose mouth he exhibited). In the case of deaf mutes the prominence was entirely absent.

Professor Elliot Smith, in the discussion that followed, said that the growth of the brain was the primary factor in human evolution. Man became human because of the growth of the brain; the erect attitude and the use of the hands were secondary matters. He did not think the jaw originally had anything to do with the power of articulate speech. The growth of the jaw was not an isolated factor in the face; it was not the jaw alone, but the whole character of the facial bones. When man began to speak he was already provided with the means for articulating his speech, and we saw the gradual development of the speech muscles before the human stage was reached.

Professor Boyd Dawkins, referring to the relation of the hand to the brain, said that when a terrestrial habit was adopted by man, the climbing instrument was converted into the most wonderful instrument in the world—the hand. Freedom from walking and climbing gave the opportunity for that to be used for other purposes. The evolution of the hand from the foot emphasized an important influence in the development of the brain. He thought that little children, by handling, and feeling, and stretching out their hands, obtained their first idea of distance. The question of distance and space was primarily based on the possession of the hand, and with the enlargement of the faculties of the hand you had the enlargement of the brain.

Sensibilities of the Human Organism

FOR many decades physiologists have devoted their attention more earnestly to the study of the marvelous mechanism of the special senses than to the general sensibilities of the body. The latter in fact were lumped under the general heads of touch and pain. Modern scientists, however, have of recent years found a vast field of research among these general sensibilities, and it is now conceded that they surpass the special senses in biological importance. This is not merely because pain is the faithful watch-dog which guards the gateway to the palace of health, but because it is believed that from the sense of touch and the other general sensibilities which are now known to be numerous, most of our fundamental conceptions of the universe are gained, particularly those of space and force. The case of Helen Keller alone bears striking witness to the high degree of brain development which dependence on these sensibilities renders possible.

It is far harder to define and to limit these avenues of sensation than those of sight and hearing. Neither the phenomena themselves nor the theories they suggest are as yet fully known and developed. An enormous amount of work in this fruitful field has however, been done very recently and some of the knowledge thus obtained is of vital significance to physiologist and physician.

In a recent number of *Die Naturwissenschaften* Dr. Otto Veraguth of Zürich gives an admirable analysis of the subject, indicating results thus far obtained, and the avenues which still invite the investigator. The definition of the sensibilities as the afferents which flow through the spinal ganglia and their analogues toward a center in the brain can be accepted only with reserve; else we should improperly exclude a not unessential part of the nervous system. It is quite untenable to consider the sensibilities confined to those which arouse a specific sensation in the mind. In fact, none of the sense functions can be exclusively defined from such a subjective standpoint.

The sensibilities may be divided into two groups, simple and compound. The first may be analyzed

according to two criteria—their objective and their subjective phenomena.

(*a*) Objective criteria.

1. Quality of adequate stimulus.
2. Source of adequate stimulus.
3. Location of receptors.
4. Location of responsive organs.

(*b*) Subjective criteria.

1. Quality of sensation.
2. Associated valence.
3. Affective valence.
4. Degree of consciousness.

The series of adequate stimuli begins with effects of force having *one* maximum (1, pressure stimulus); then follow those with many maxima, especially those with an irregular consequence of the maxima (2, stimulus of a series of pressures; 3, stimulus of elastic response); then those with regular maximal rhythm and also with increasing speed (4, vibration stimulus; 5, electric stimulus; 6, minus-temperature stimulus; 7, indifferent-temperature stimulus; 8, plus-temperature stimulus; and finally the stimuli due to molecular motions in the form of chemical stimuli).

Von Frey's method of determining points sensitive to pressure by means of an adjustable horse-hair is the best. Such points are irregularly distributed both on skin and on mucous membrane. Other methods are used to determine effect of outside pressure upon deep-lying interior organs.

Elastic-strain stimuli form one of the most biologically important groups. The solid parts of the body can be arranged in a series accordingly, at one end being the muscles, tissues whose chief biological property is flexibility and extensibility, at the other end the rigid bones.

For vibration stimulus we have a source in our own body—the formation of the voice in the larynx and organs of resonance. But vibrations are felt elsewhere, as in the bones, as can be proved by using a tuning fork with a broad base.

The electric stimuli thus far used as tests include the galvanic current with variations of intensity, the primary and secondary Faradaic current, and the sinusoidal current. The adequate temperature stimuli include those which just do not affect consciousness and those of higher and lower degrees. This division cannot be marked by exact figures, since individuals vary at different times as well as from each other. It has been learned that spots sensitive to heat or cold are irregularly distributed on the skin.

Chemical stimulus is felt only when strong enough to overcome the protective function of the epidermis. On the mucous membrane, however, the chemical stimulus of *taste* is operative.

We owe to Skerrington the division into exteroceptive, interoceptive, and proprioceptive sensibilities. The first are those proceeding from outside and acting on skin or through it on the interior. The second includes all those whose point of attack is on the inner surfaces of the body. The third includes whatever else operates within the body.

As regards location, the sensibilities are either superficial or deep-lying. The first may be regarded as those whose receptors are distributed outside the connective tissue membrane in the lower cell-tissue and further all those whose receptors are imbedded in the mucous membranes of the inner receptors, and finally the naked upper surfaces of the eyes. The superficial play an important role in the recognition and localization of certain nervous maladies. . . . Thus if a given area of the skin lacks sensitiveness we conclude there is a lesion of the nerve leading to it, and in the last decade we have begun to determine what superficial area is disturbed when the lesion is not in the peripheral nerve but in one of its roots or in a segment of the spinal cord.

Again, the topography of the superficial sensibility is quite different when considered in relation to the brain.

The deep-lying sensibilities must be divided into subgroups according to location in muscles, tendons, ligaments, joints, vessels and other viscera.

The brain itself is the only part of the body of whose mechanical injury the patient is not conscious. It is curious to see (as one may in some cases of diagnosis) hollow needles being thrust into the brain to a depth of 2 to 3 inches without the patient's knowledge after a slight and superficial local anesthesia.

The sensibilities of the internal organs are not generally within the field of consciousness, but experiments by physicians have proved them to exist.

Comparatively little has as yet been learned about the visceral sensibilities, but two remarkable facts may be mentioned: 1. The normal intestinal peritoneum is insensible to pressure or piercing, but highly sensitive to tension. 2. Pains whose cause lies (for example) in the liver, may be felt in the region of the shoulder-blades. These and similar irradiated sensations are explained by the fact that the paths of sensation from the abdominal viscera scatter in the spinal cord in the same localities in which the nerves from those parts of the skin which feel pain also terminate. But since our *psyche* is commonly conscious only of exteroceptive stimuli, it interprets the irritation in the spine as coming from the skin instead of the viscera.

The organs of response all lie (if we disregard the peripheral sympathetic system) in the spinal cord, the medulla oblongata, the cerebellum and the external layers of the cerebrum. Stimuli which reach the highest point in one consciousness traverse portions of the periphery and *en route* under certain conditions many other organs of response having nothing to do with consciousness may be set in action. When a spinal lesion occurs high up, thus cutting off the manifold inhibitions proceeding from the brain, we may see striking examples of response to stimuli proceeding from the cord itself, since many motor reactions which are ordinarily inhibited may be observed. Thus the legs of such patients, which they are unable to move, may be made to have a so-called spontaneous motion by an application of cold to the trunk, and it is an established fact that such patients in time come to know what part of the skin to pinch to induce the emptiness of the bladder which they are no longer able to accomplish voluntarily by reflective action.

On the subjective side the simple sensibilities are most easily divided according to the quality of the sensation. The two categories, tickling and pain, demand especial attention. The first probably proceeds exclusively from exteroceptive stimuli, especially through series of pressures—hence, through a sequence of pressures at different points of attack. But it may also be produced by vibration, as when a tuning fork is placed on the tongue or the end of the nose.

Pain can be produced by every stimulus, if of sufficient intensity. The degree of intensity required probably depends on the importance to the organism of the organ threatened. Pain as a subjective phenomenon is naturally a function only of the higher organs of response. In this connection hysteric insensibility to pain may be noted. There are hysteric patients who may be pinched, pierced or burnt without being conscious of it.

The simple sensibilities usually come into play in association. Hence there are certain characteristic phenomena of sensibility which predominate among the mass of possible combinations and which are of great importance both for normal physiology and in the diagnosis of disease.

1. *The sensation of the unmoved position of a portion of the body.* Usually we know without looking where any part of the body is; but in certain stages of spinal diseases the patient has no notion in what part of the bed his legs are when they are hidden by the cover.

2. *The sensation of the passive motion of a part of the body.* This is probably mainly a result of joint-sensibility.

3. *The sensation of the active motion of a part of the body.* The difference between this and the former is best shown by an experiment in the bath. When we allow the arm to be lifted by the water we have the sense of passive motion. But if we move it by our own volition we have an added sensation of muscular force exerted. It was this difference of sensation which gave Archimedes the idea of the law of specific gravity.

4. *We also have a faculty of delicate quantitative evaluation for the effect of complicated exogenous mechanical forces acting on the organism in areas of broad surface.* Examples are thrust, blows, pressure, gravity, centrifugal force, etc. The labyrinth of the inner ear is of especial assistance in such cases.

5. *For purposes of diagnosis a very important effect of such co-ordinated sensibilities is stereognosis, the capability of recognizing or judging merely by touch the form and nature of an object.* The hands are supremely fitted for this, but the cavity of the mouth and the forward part of the sole of the foot also have a degree of stereognostive ability. This we can ordinarily distinguish readily between the denominations of various coins held in the hand by the size, weight, milling on the edge, etc. But there are diseased conditions in which this power is diminished or destroyed. This is one of the best-known symptoms in disturbances of the parietal lobes of the brain. But it may also be due to disease of the peripheral nerves of the hand.

New German Motors Demonstrated.—After making a number of improvements and greatly increasing the horse-power of his best former motors (those used in the German airships L. Z. XX), engineer Maybach, a noted inventor of aeronautic motors, recently selected Count Zeppelin's 75th birthday for a public demonstration of the results of his latest work. Maybach has so improved his motor that an airship equipped with the new type will develop 800 horse-power as compared with 500 horse-power developed by the airship "Victoria Louise" of two years ago. This steady advance shows what an adequate investment, the large sums contributed by the German people, can do for the commercial development of aerial navigation.

Geology of Oil Little Understood

THE principles governing the origin and mode of occurrence of petroleum and natural gas are as yet but fragmentarily grasped by geologists. Every oil field examined in detail contributes its data for use in the eventual interpretation of the problems, and each pool is studied with keen alertness for the discovery of some key that may aid in the co-ordination of the data, which sometimes, according to the region and conditions, seem, on account of our lack of knowledge, even to be in conflict. The observations made by the geologists of the United States Geological Survey in the oil and gas fields of California and Kentucky promise to further the solution of some of the problems, and by pointing out the relations of oil and gas occurrence to the geologic structure of the regions examined they have rendered important scientific as well as economic aid in oil and gas development; but the basic principles controlling the widely varied modes of occurrence and accounting for the differences in kinds of the oils in widely separated regions are possibly still far from view.

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